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Multiparameter Numerical Medium
for Seismic Modelling, Planning,
Imaging & Interpretation QC
Worldwide

TESSERAL GEO MODELING SUITE

Windows Workplace (Pro V4.1)

User Manual

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1 About Tesseral Pro

Tesseral Pro is designed for calculating seismic synthetic gathers using finite-difference wave equation approximations, such as acoustic, elastic, anisotropic, visco-elastic and 2D ray-tracing (approximation by eikonal equation). In the Tesseral Pro, the depth velocity models can be built from well data, geological surface maps or 2D/3D grids.

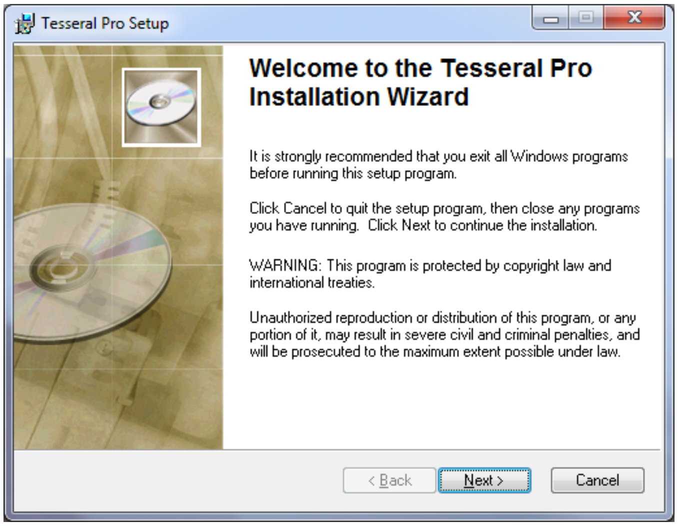
Also Tesseral Pro allows building a 3D observation system and performing 3D Ray tracing.

2 Tesseral Pro package download and Installation

The latest versions of the Tesseral products can be downloaded from the following links:
http://www.tesseral-geo.com/download.en.php
The setup package for Tesseral Pro can be downloaded via:
http://tesseral-geo.com/download/tesseral_pro_setup3.zip
To start the setup process, please unzip the file "Tesseral_pro_zetup.zip" and then run the executable.

NOTE: If you have purchased the Tesseral Pro USB-key license, please do not insert your USB key before finishing the installation. The drivers for USB key will be set up during the installation.

After successful installation, a `Welcome` dialog (below) will appear.



Welcome to the Tesseral Pro Installation Wizard

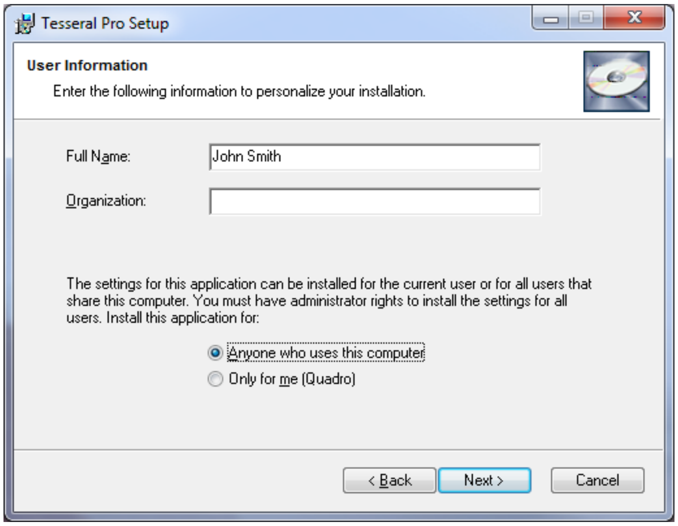
It is strongly recommended that you exit all Windows programs before running this setup program.

Click Cancel to quit the setup program, then close any programs you have running. Click Next to continue the installation.

WARNING: This program is protected by copyright law and international treaties.

Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.

In the `User Information` dialogue box you may enter your name and specify if other users can use Tesseral Pro on this computer (the current user only or all the users of this computer).



User Information

Enter the following information to personalize your installation.

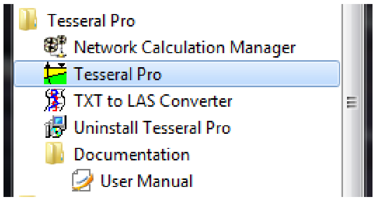
Full Name: John Smith

Organization:

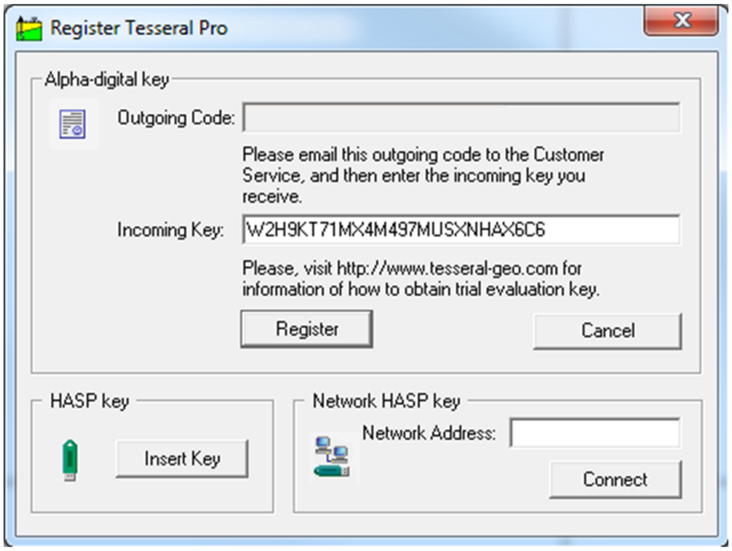
The settings for this application can be installed for the current user or for all users that share this computer. You must have administrator rights to install the settings for all users. Install this application for:

● Anyone who uses this computer
○ Only for me (Quadro)

After installing Tesseral Pro, just click "Tesseral Pro" in the start menu to start Tesseral Pro:


Tesseral Pro
Network Calculation Manager
Tesseral Pro
TXT to LAS Converter
Uninstall Tesseral Pro
Documentation
User Manual

When Tesseral Pro is started for the first time, you need to enter your registration information or insert your USB key (see Licensing Policy at Section *18*). After registration, the program is ready for use.


Register Tesseral Pro
Alpha-digital key
Register
Cancel
HASP key
Insert Key
Network HASP key
Connect

Outgoing Code:

Please email this outgoing code to the Customer Service, and then enter the incoming key you receive.

Incoming Key: W2H9KT71MX4M497MUSXNHAX6C6

Please, visit http://www.tesseral-geo.com for information of how to obtain trial evaluation key.

Network Address:

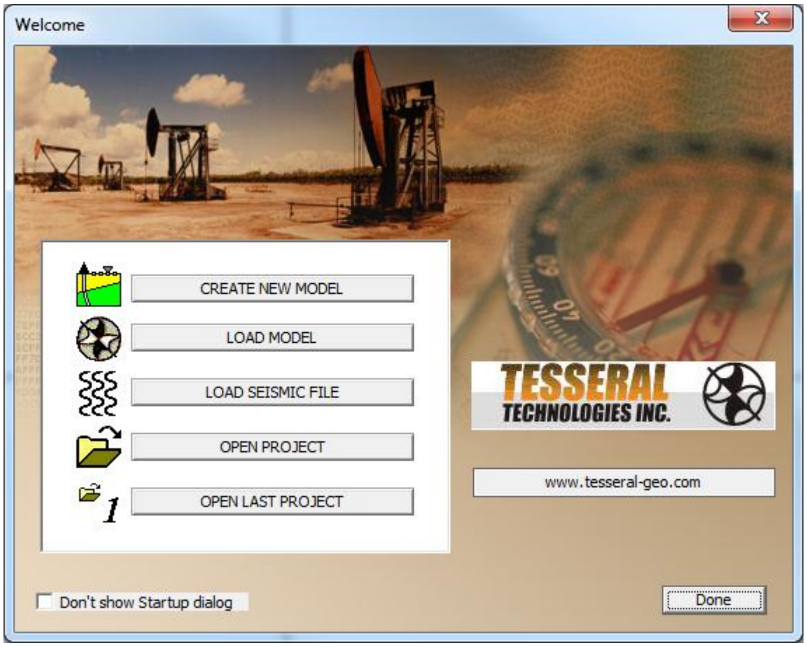
Without a license, in the demo mode, the functions of synthetic gathers modeling and gathers processing are unavailable for the users.

2.1 System Requirements

Minimum	Recommended
Windows XP/Vista/7 1.6 GHz CPU 512 MB RAM 400 MB free space on HDD	Windows XP/Vista/7 2.3 GHz CPU 1 GB RAM 2 GB free space on HDD Network Card (access corporate database)

3 Introduction

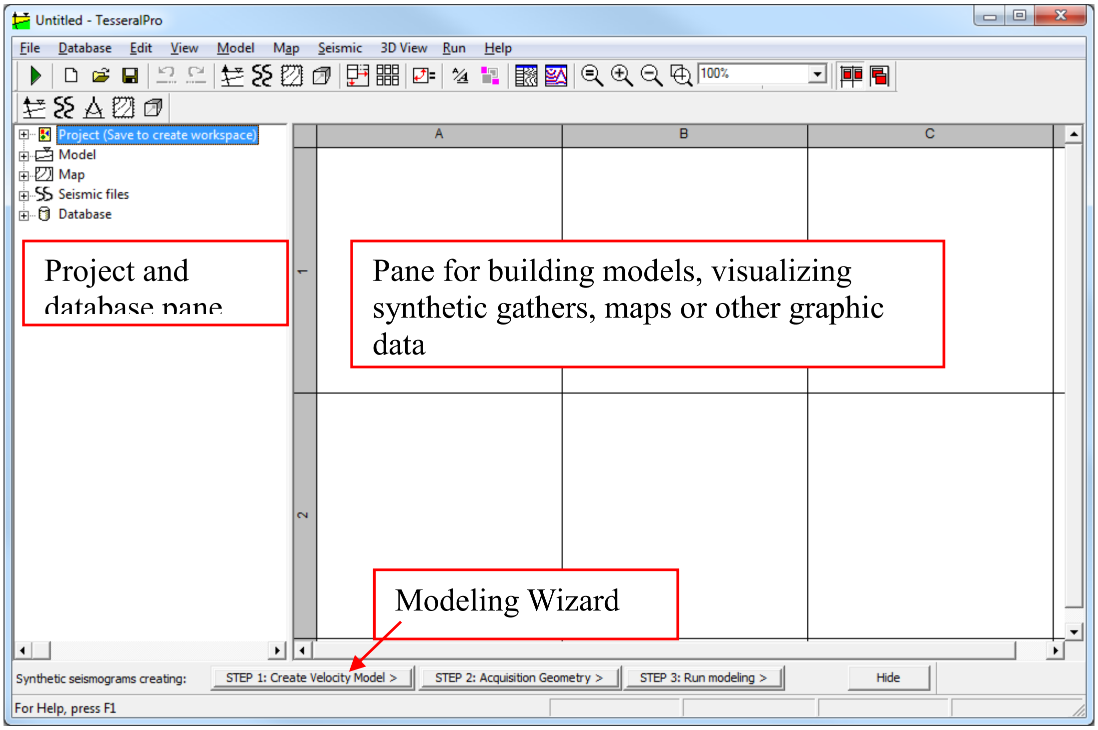
After launching the Tesseral Pro, a `Welcome` dialogue box with several options appears.


Welcome
CREATE NEW MODEL
LOAD MODEL
LOAD SEISMIC FILE
OPEN PROJECT
OPEN LAST PROJECT
TESSERAL TECHNOLOGIES INC.
www.tesseral-geo.com
☐ Don't show Startup dialog
Done

- The `CREATE NEW MODEL` button launches the Wizard to create a new model (Section ***4.1***).
- The `LOAD MODEL` button is for loading a model in TAM format used in the Tesseral 2D program, WGC format, GXII format or loading a model from a text file in various formats (Section ***4.10***).
- The `LOAD SEISMIC FILE` button enables the visualization of gathers in standard SEG-Y, internal TGR and SDS-PC formats (Section ***13.1***).
- The `OPEN PROJECT` and `OPEN LAST PROJECT` buttons are for loading the files of Tesseral Pro projects.

If you click `Done`, the standard empty window of the Tesseral Pro project will appear.

3.1 Layout of Tesseral Pro window


Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
Project (Save to create workspace)
Model
Map
Seismic files
Database
A
B
C
1
2
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

Project and database pane

Pane for building models, visualizing synthetic gathers, maps or other graphic data

Modeling Wizard

In the left panel the database tree (please see description in the Section *17*) and the project tree (please see details in the Section *11.8*) are displayed. The right panel is for building the model and visualizing gathers, maps or 3D images. All the objects in the right pane are displayed in rectangular frames (please see details in the Section *11*).

At the bottom of the main Tesseral Pro window is the `Modelling Wizard`, which initiates one of the 3 main steps in a modeling process (Section *3.3*).

3.2 Menu overview

- Menu `File` consists of the options for creating, saving or importing a project (TPA format), loading models, gathers or surfaces, printing document and exporting the project into standard raster-type or vector formats.
- Menu `Database` is for managing the database in Tesseral Pro, such as creating/selecting database, or importing/editing a well log data (see Section ***17***).
- Menu `Edit` is for manipulating Frames.
- Menu `View` is for general commands for working with Frames.
- Menu `Model` is for creating and modifying velocity models and acquisition geometry (Section ***12***).
- Menu `Map` is for creating/loading a surface map and different ways of displaying the surface map (Section ***14***).
- Menu `Seismic` is for loading seismic gathers in SEG-Y, SDS-PC or TGR formats (Section ***13***) and changing the visualization modes.
- Menu `3D View` is for viewing 3D images (Section ***15***).
- Menu `Run` is for launching computation of synthetic gathers for one particular model or to process these synthetic gathers using available processing modules such as stacking and 2D migration (Section ***7***, *Помилка! Джерело посилання не знайдено.*).

3.3 General steps for synthetic modeling

At the bottom of the Tesseral Pro window, the 3 sequential steps for creating synthetic gathers are shown:

STEP 1. Creation of the 2D velocity model. The velocity model can be created by using well data, maps of horizons or 2D/3D layered model (SEG-Y format) or LAS file). 1D/2D vector models in various formats from other packages are also supported (Section ***4.1***).

STEP 2. Creation of the acquisition geometry (source and receiver distribution, section ***6***)

STEP 3. Set-up of the modeling parameters and start a modeling job which launches one of the following computational engines (Section *7*):

1. 2D/3DVertical Incidence
2. 2D Scalar
3. 2D/3D Acoustic
4. Acoustic without multiples
5. 2D/3D Elastic
6. 2D/3D Elastic Anisotropic
7. 2D/3D Visco-Elastic
8. 2D Eikonal Ray Tracing
9. 2.5D Elastic
10. 2.5D Elastic Anisotropic
11. Haskell−Thomson

The procedures for processing gathers (Section *Помилка! Джерело посилання не знайдено.*) and the module for ray tracing (Section ***8***) are integrated into Tesseral Pro.

4 Depth model building

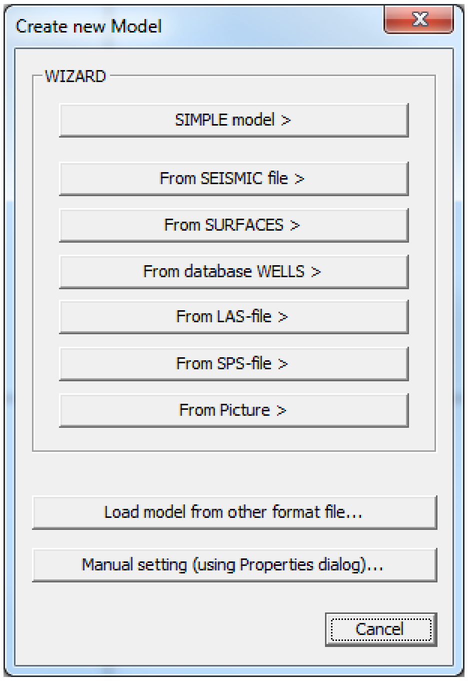
To create a depth-domain velocity model in Tesseral Pro, a `Model` Frame is to be used.

All the objects in the Tesseral Pro are comprised in Frames; see Section ***11*** for details related to different types and options for manipulating frames.

In the `Model` Frame users can build arbitrarily complex velocity models for any geological structure, add anisotropic or fracturing parameters into the background model and design the acquisition geometry. The geological model is built by overlapping a set of polygons. Within each polygon, the rock physical parameters could be homogeneous or complicated (with a linear gradient along depth). For model creation, users can use the reflection horizons, velocity, density, anisotropy and other parameters from acoustic well logging, grids of layer data in SEG-Y format, as well as 1D/2D vector models from other packages.

4.1 Building a new model

The first stage of model building is to specify the basic parameters: size of the model (width and depth), geographical reference of the coordinates, and the main source of data used for building models (grids in SEG-Y format, grids or isolines of reflection surfaces, well data, underlying image and etc). The menu `Model > Create Velocity Model (New Frame)` is used. After that, the Wizard for new model creation will appear.


Create new Model
WIZARD
SIMPLE model >
From SEISMIC file >
From SURFACES >
From database WELLS >
From LAS-file >
From SPS-file >
From Picture >
Load model from other format file...
Manual setting (using Properties dialog)...
Cancel

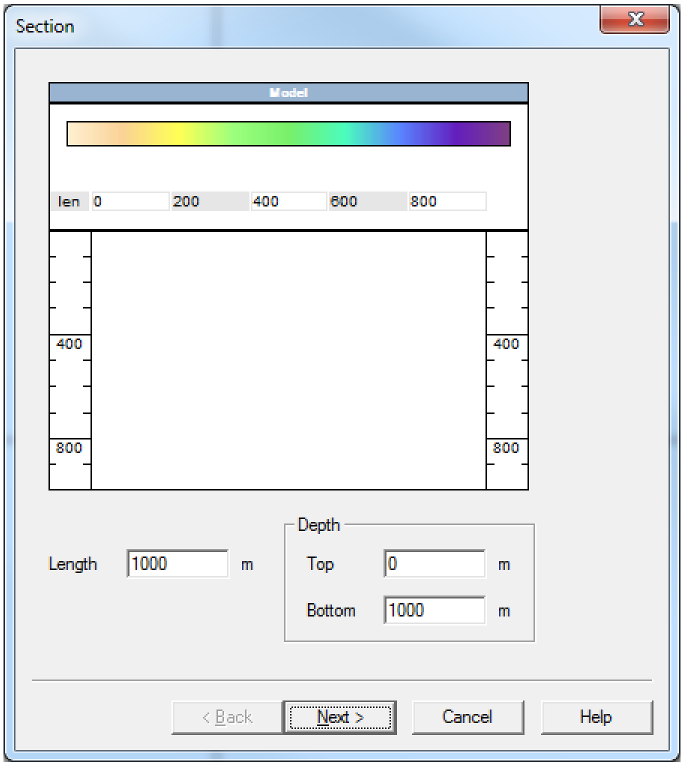
In this dialogue box, users can select one of the main data sources for creation of a depth model. In the next chapters, various options for model building will be described one by one.

4.2 Creation of a simple 2D model

Firstly, click the menu `Model > Create Velocity Model (New Frame)`. Then, select `SIMPLE model >` in the `Create new Model` pop-up dialogue box.

In the `Section` dialogue box, specify the model's length and the top and bottom of the depth model.

NOTE: The distance units in the model may be meters or feet. Select the measurement units in the project as described in the Section *16*.



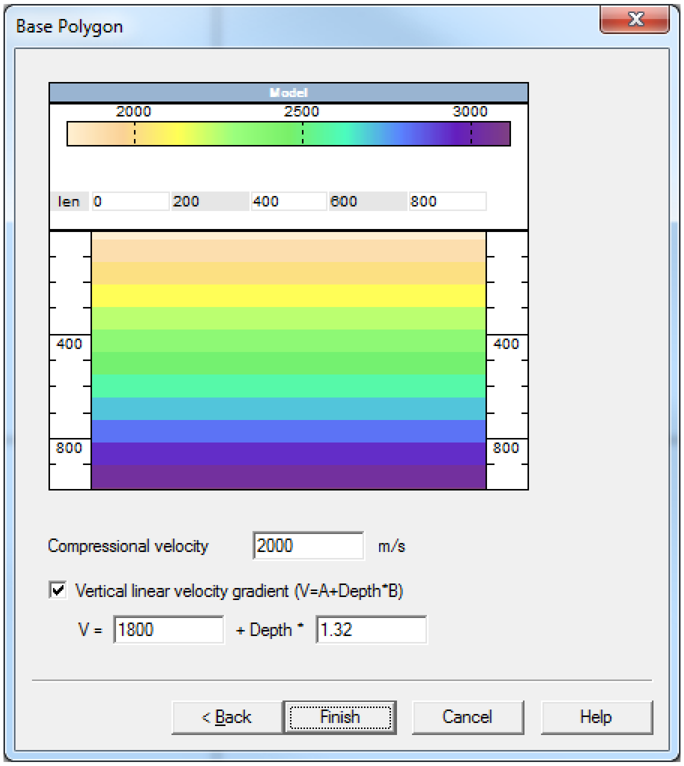
Length 1000 m

Depth

Top 0 m

Bottom 1000 m

After specifying model's size, click `Next`. You will see the `Base Polygon` dialogue box where the constant or linearly-increasing compressional velocity of the background model (base of the other polygons) can be specified.

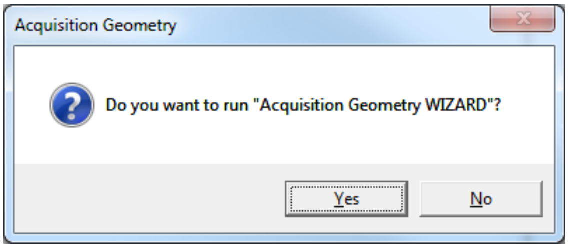

Base Polygon
Model
2000
2500
3000
len
0
200
400
600
800
400
800
< Back
Finish
Cancel
Help

Compressional velocity 2000 m/s

☑ Vertical linear velocity gradient (V=A+Depth*B)

V = 1800 + Depth * 1.32

After clicking `Finish`, the Frame Model will be created, and you will be asked to design the acquisition geometry used for modeling, as shown below:


Acquisition Geometry
Yes
No

Do you want to run "Acquisition Geometry WIZARD"?

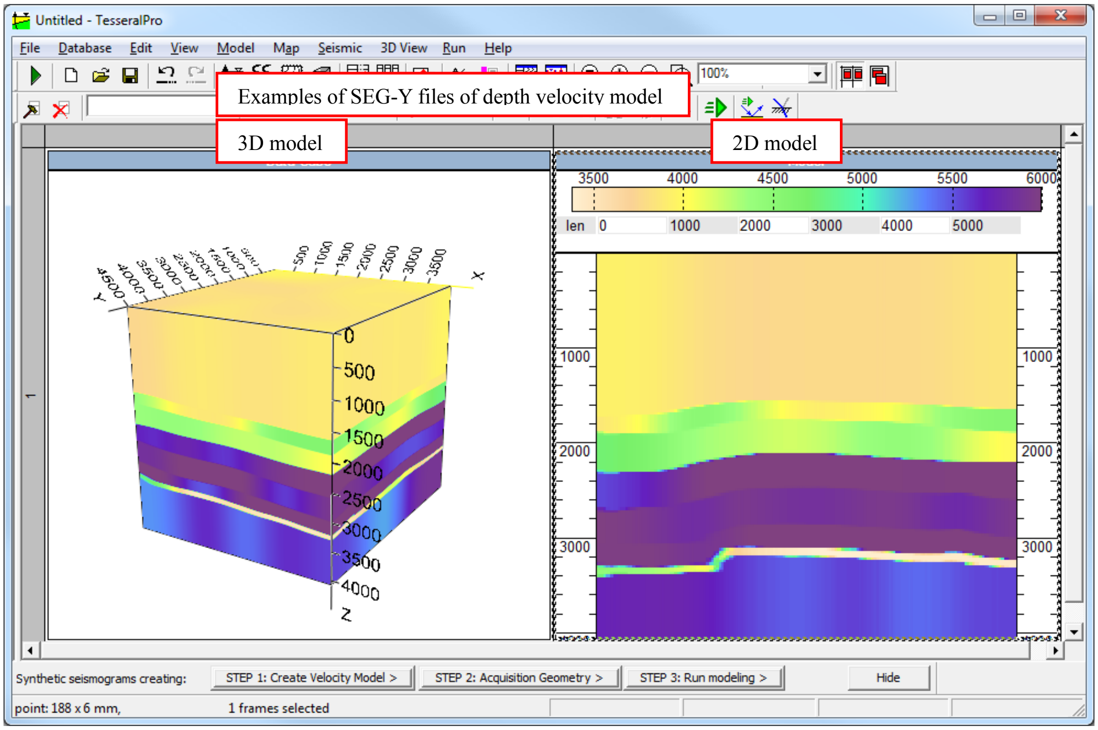
This message will always pop up after creating a new model. Please see more details about designing related source/receiver distribution in the Section *6*.

After the "empty" Frame Model is created, it has to be overlapped with polygons with various velocities, density and other rock physical parameters. Please see more details about how to build a model using polygons in Section *4.11*.

4.3 Creation of a model from a SEISMIC file

If you have a 2D or 3D velocity depth model in SEG-Y format, you can use it as an underlying image for the model.

For example:



Examples of SEG-Y files of depth velocity model

3D model

2D model

Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
3500 4000 4500 5000 5500 6000
len 0 1000 2000 3000 4000 5000
1000
2000
3000
0 500 1000 1500 2000 2500 3000 3500 4000
X
Y
Z
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 188 x 6 mm,
1 frames selected

This means that, instead of drawing polygons and adjusting their parameters, users have the option of using SEG-Y files directly. Users only need to select the size and location of the model. If the SEG-Y files contain only compressional velocity, then the other parameters (shear velocity, density) will be calculated automatically by using some empirical formulae. Importing density, shear velocity and anisotropy from SEG-Y files is also supported.

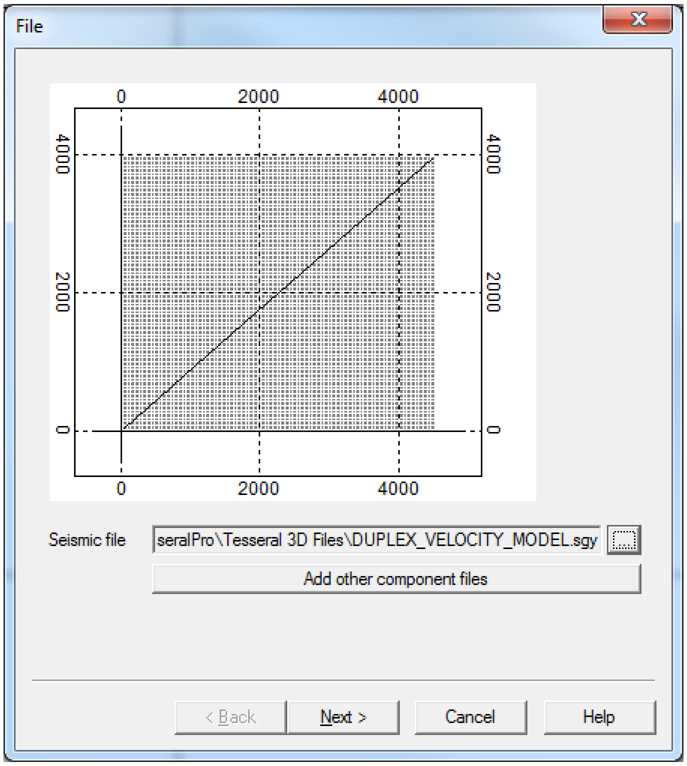
The time-domain model in SEG-Y format may also be used. But it needs to be transformed into depth model in advance; the Run > Velocity Model > Time to Depth Transformation menu is used for this purpose. Please see more details in the Section *10.2.2*.

> **NOTE**: In Tesseral Pro, SEG-Y files can be visualized by using the menu `Seismic > Load Seismic File (New Frame)` (please see the Section *13* for details)

After clicking the `Model > Create Velocity Model (New Frame)` menu, you will see the `Create new Model` dialogue box. Then click the `From SEISMIC file >` button to build the model from the seismic file.

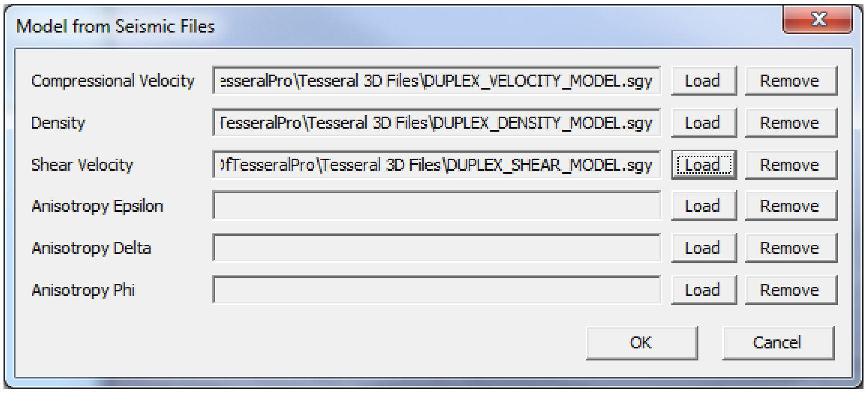
STEP 1. Selection of a SEG-Y file with velocities

In the `File` dialogue, please select the 2D or 3D seismic file in one of the SEG-Y or TGR formats.


File
0
2000
4000
4000
2000
0
Add other component files
< Back
Next >
Cancel
Help

Seismic file: seralPro\Tesseral 3D Files\DUPLEX_VELOCITY_MODEL.sgy

Apart from the compressional velocity data, you may also have depth-domain seismic files with density, shear-wave velocity or anisotropy data. These files may be also used as the underlying image for the corresponding components. Click the `Add other component files` button to select the files of other components in the `Model from seismic files` pop-up dialogue box.

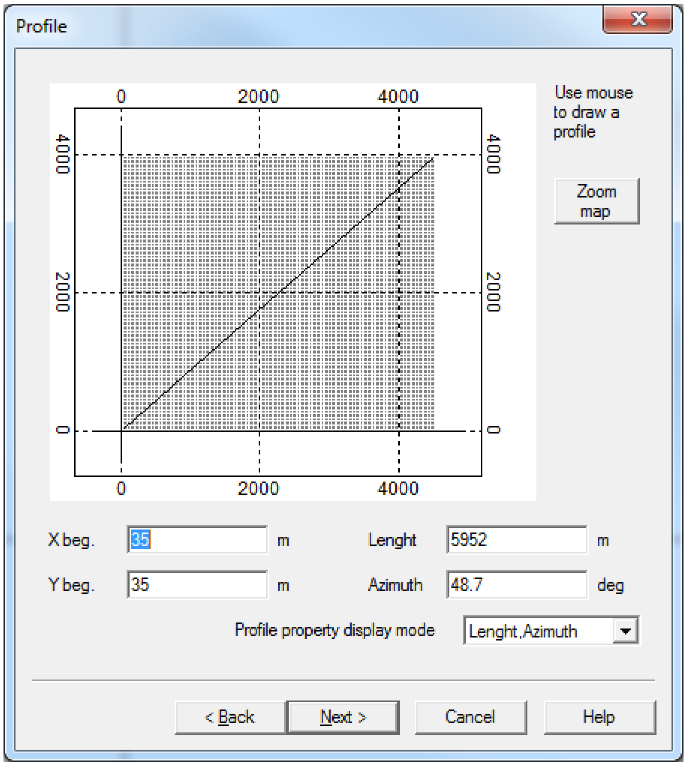

Model from Seismic Files
Load
Remove
OK
Cancel

Compressional Velocity: :sseralPro\Tesseral 3D Files\DUPLEX_VELOCITY_MODEL.sgy
Density: TesseralPro\Tesseral 3D Files\DUPLEX_DENSITY_MODEL.sgy
Shear Velocity:)fTesseralPro\Tesseral 3D Files\DUPLEX_SHEAR_MODEL.sgy
Anisotropy Epsilon:
Anisotropy Delta:
Anisotropy Phi:

When the seismic file is selected, press the `Next >` button.

STEP 2. Selection of coordinates and the Model profile

In the next dialogue box `Profile`, if the seismic file is 3D, users need to enter the coordinates of the model profile, or draw the profile manually in the plan by pressing-dragging and releasing the left mouse button.


Profile
0
2000
4000
4000
2000
0
Zoom map
< Back
Next >
Cancel
Help

Use mouse to draw a profile

X beg. 35 m

Y beg. 35 m

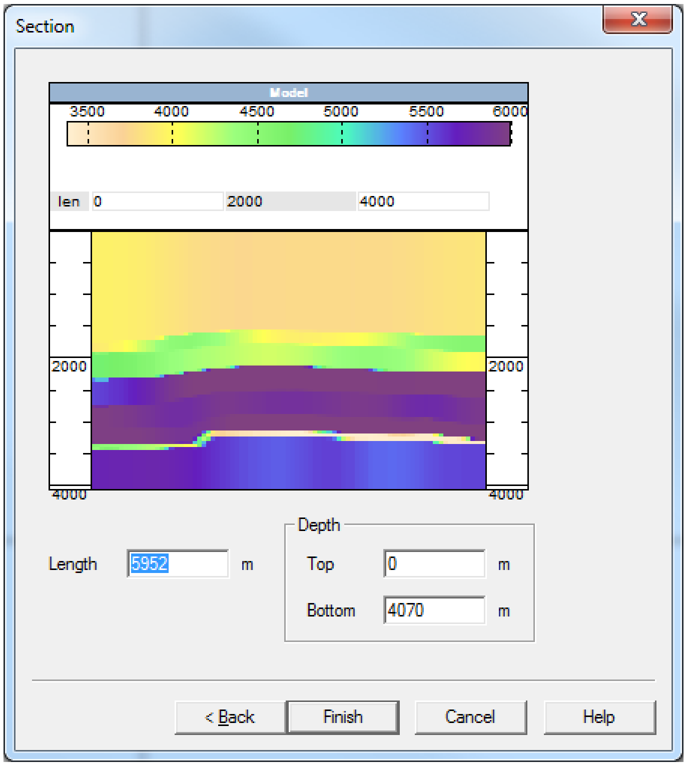
Lenght 5952 m

Azimuth 48.7 deg

Profile property display mode Lenght,Azimuth

STEP 3. Size of the model

In the next dialogue box `Section`, please specify the top and the bottom of the model:


Section
Model
3500
4000
4500
5000
5500
6000
len 0
2000
4000
2000
4000
< Back
Finish
Cancel
Help

Length 5952 m

Depth

Top 0 m

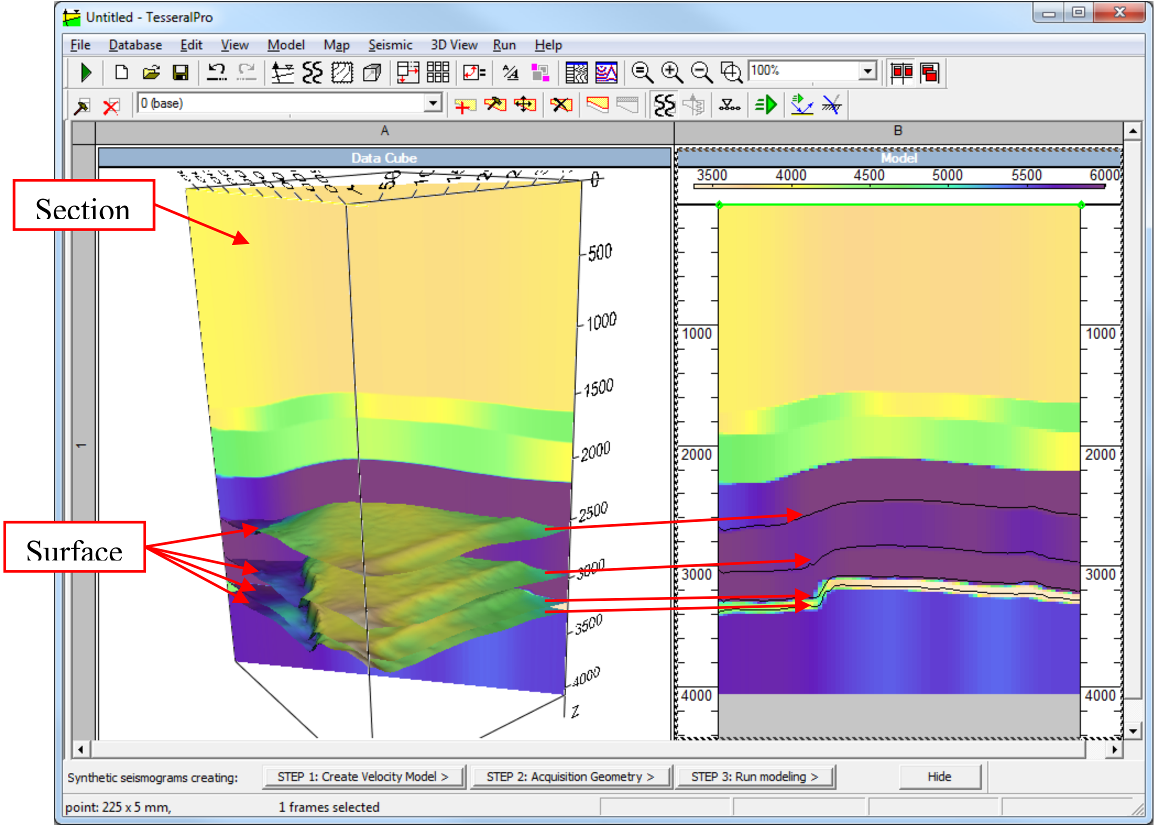
Bottom 4070 m

The model with the underlying seismic file is ready. Then, the users will be asked to design an acquisition geometry for the model (please see the Section *6* for details).

Users may add polygons above the underlying image to finalize the model building. In Section *4.9*, see details about how to adjust the model's parameters, which have an underlying SEG-Y image.

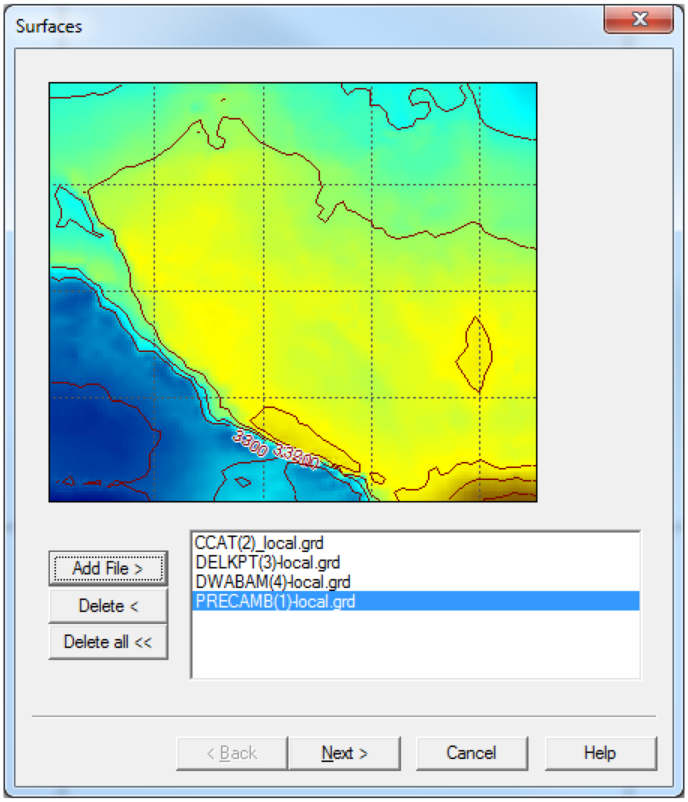
4.4 Creation of a model from SURFACES

The grids or isolines of the reflection horizons may be used for the automatic creation of model's polygons. In this case, the 2D model is built as a vertical section in the 3D cube of surfaces (see figure below). As a result, the top and the bottom of each polygon have the same shape as the surfaces for the given section.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
0 (base)
A
B
Data Cube
Model
0
500
1000
1500
2000
2500
3000
3500
4000
Z
3500
4000
4500
5000
5500
6000
1000
2000
3000
4000
Section
Surface
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 225 x 5 mm,
1 frames selected

To use this function, first click `Model > Create Velocity Model (New Frame)`, and then in the dialogue box `Create new Model` click the button `From SURFACES >`.

In the opened dialogue box `Surfaces` click the button `Add File >` if a surface is going to be loaded from the file into the Tesseral Pro project (see figure below).



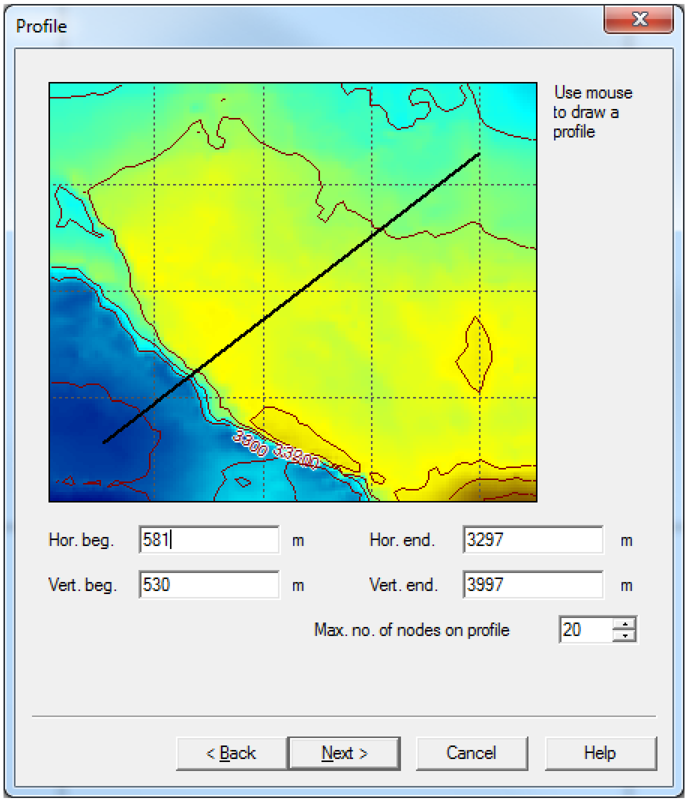
CCAT(2)_local.grd
DELKPT(3)_local.grd
DWABAM(4)_local.grd
PRECAMB(1)_local.grd

After you have selected the files with surfaces, the dialogue box `Choose mapping method` will appear, and then the dialogue box `Calculate Isolines` will appear for adjusting the parameters of the isoline image. Repeat these steps to add more layers. When all the needed surfaces are loaded, press the button `Next >`.

NOTE: You may select several surfaces at a time in the `Add File >`.

In Tesseral Pro, the surfaces may be loaded directly from files that have major text formats, or may be calculated from stratigraphic well data. Please see Section *17* about loading stratigraphic data into the database. Section *14.2* describes the functions for computing surfaces from well data.

In the next dialogue box `Profile` please specify the profile coordinates manually or draw the profile using the mouse (press-drag-release).


Profile
Use mouse to draw a profile
3300
3300
< Back
Next >
Cancel
Help

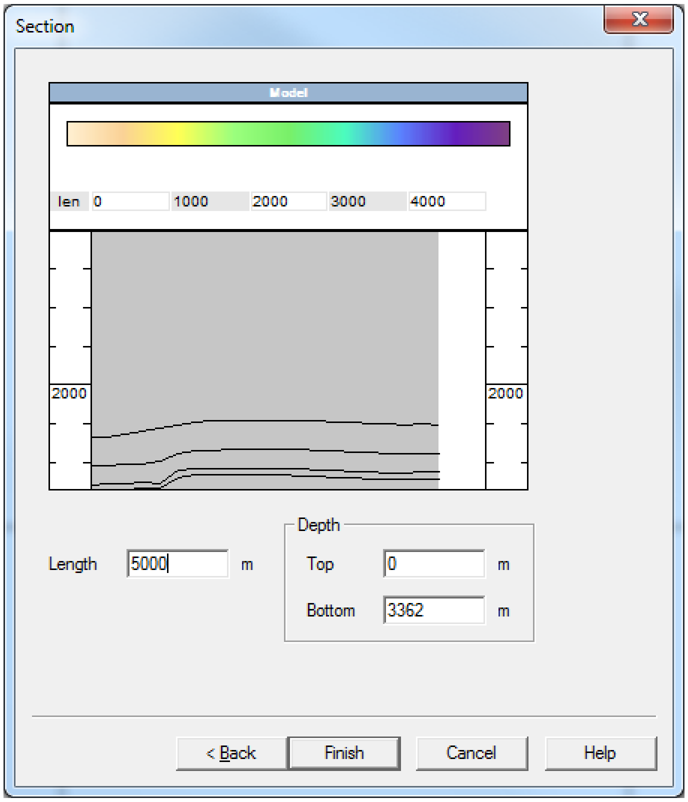
Hor. beg. 581 m Hor. end. 3297 m

Vert. beg. 530 m Vert. end. 3997 m

Max. no. of nodes on profile 20

In the figure above, the `Max. no. of nodes on profile` parameter determines the number of nodes at the top and bottom of each polygon created from the surfaces.

Press the button `Next >` to navigate to the dialogue box `Section`.


Section
Model
len
0
1000
2000
3000
4000
2000
2000
< Back
Finish
Cancel
Help

Length 5000 m

Depth

Top 0 m

Bottom 3362 m

In the dialogue box `Section` please specify the range of the model. In this dialogue box, the lines of the polygons are shown. By default, velocities and other parameters of the polygons are not present, so the polygons are displayed in grey color. To specify the parameters for each polygon, select it by mouse and then click `Model > Edit Polygon` (Section *5.5*).

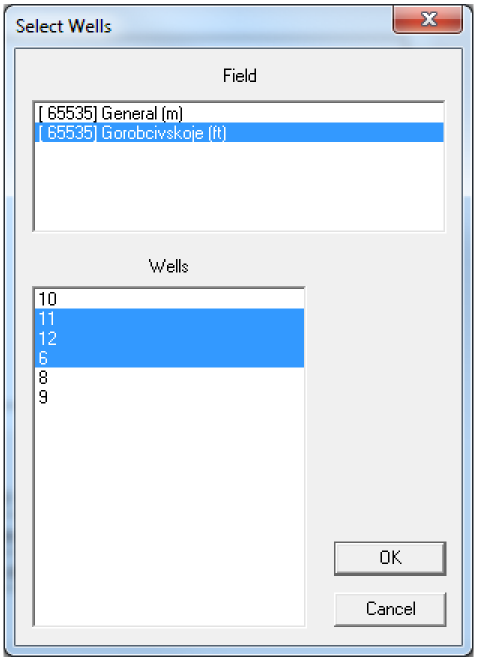
4.5 Creation of a model from WELLS

The well data (acoustic logging and/or density logging) are mainly used for creation of thin-layered models.

NOTE: To create a model by using well data, the following data need to be loaded into the database:
1) Coordinates of the wells
2) Survey directionality (if the survey has no directionality, vertical wells with provided altitudes is sufficient)
3) Depths of layer intersections
4) Acoustic (density) logging data for creating thin-layer models
Please see Section *17.5* for more details. If users wish to create a simple horizontally-layered model from one LAS-file which ignores the directionality of the survey data, please see the next Section *4.6*.

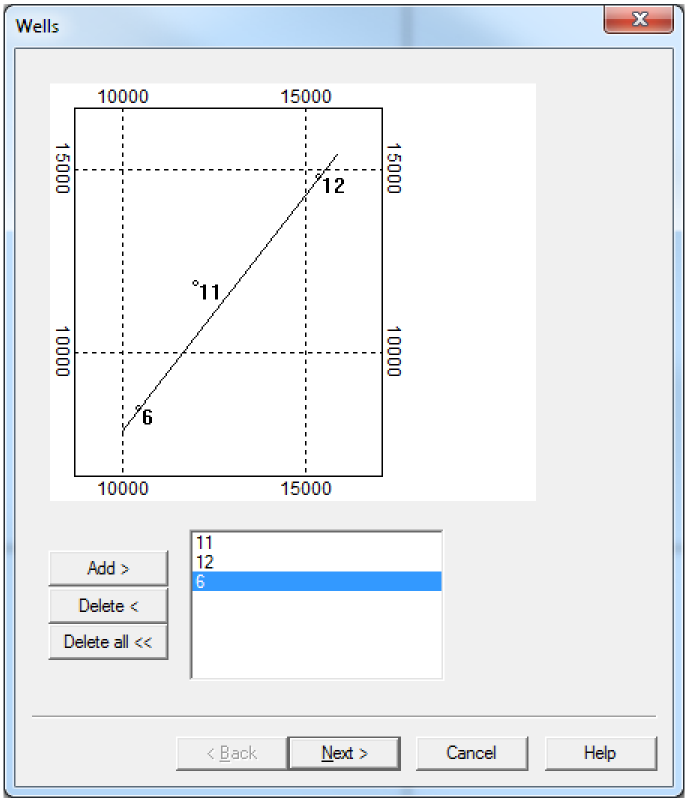
Steps for creating a model from the well data:

1. Click `Model > Create Velocity Model (New Frame)`.
2. In the dialogue box `Create new Model`, click the button `From database WELLS >`.
3. In the dialogue box `Select Wells`, select the wells to be loaded from the list of `Wells`. You may mark one or several Fields, and then in the box `Wells` only wells from these Fields will be shown.



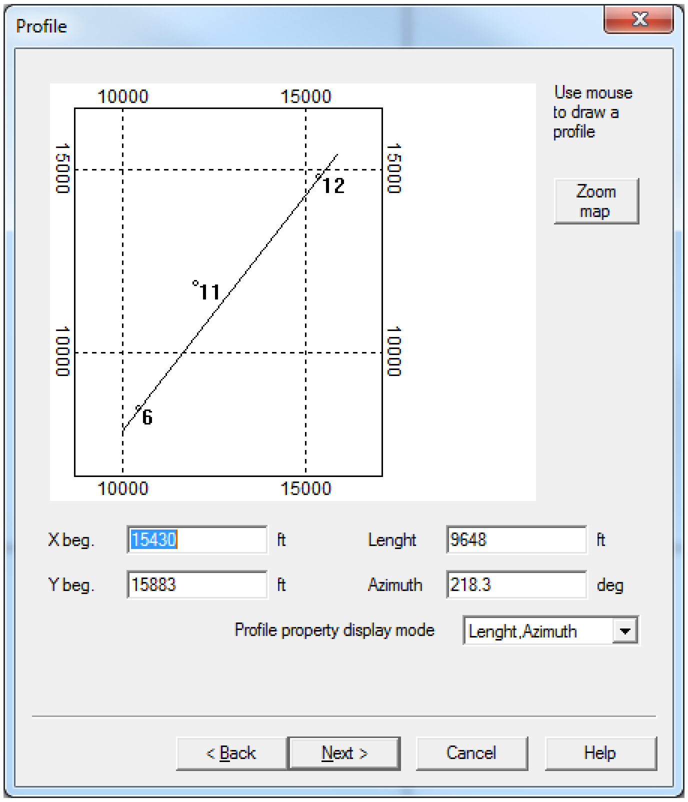
After selecting the wells, press button OK and go to the dialogue box `Wells`.

In the dialogue box `Wells`, the geographical location of the selected wells is shown, and you may add or remove wells from the profile using the buttons `Add >` and `Delete <`.


Wells
10000
15000
15000
10000
15000
10000
12
11
6
10000
15000
Add >
Delete <
Delete all <<
< Back
Next >
Cancel
Help

11
12
6

When all the needed wells are loaded into the model, press the button `Next >`. In the next dialogue box `Profile`, specify the coordinates of the model's profile or draw the profile manually by using mouse (press-drag-release):


Profile
10000
15000
15000
10000
15000
10000
12
11
6
10000
15000
Zoom map
< Back
Next >
Cancel
Help

Use mouse to draw a profile

X beg. 15430 ft

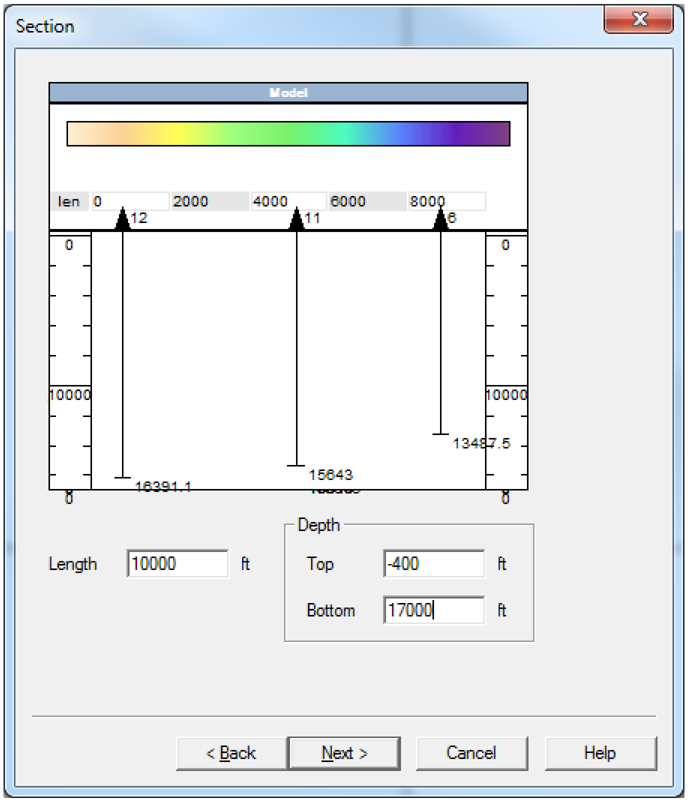
Y beg. 15883 ft

Lenght 9648 ft

Azimuth 218.3 deg

Profile property display mode Lenght,Azimuth

In the next dialogue box `Section` please set the top and the bottom of the model:


Section
Model
len 0 2000 4000 6000 8000
12
11
6
0
10000
16391.1
15643
13487.5
< Back
Next >
Cancel
Help

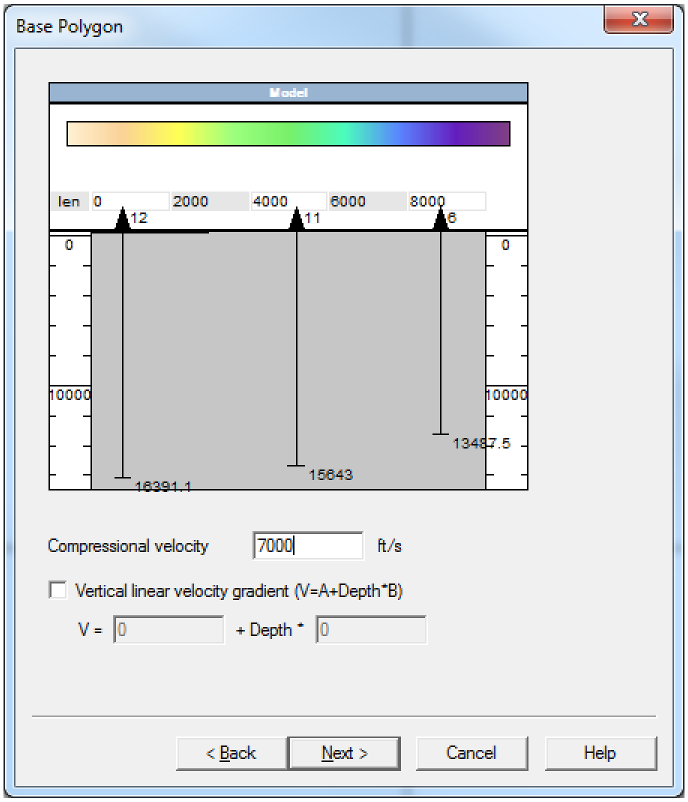
Length 10000 ft

Depth

Top -400 ft

Bottom 17000 ft

In the next dialogue box `Base Polygon`, please specify the velocity of the basic polygon:

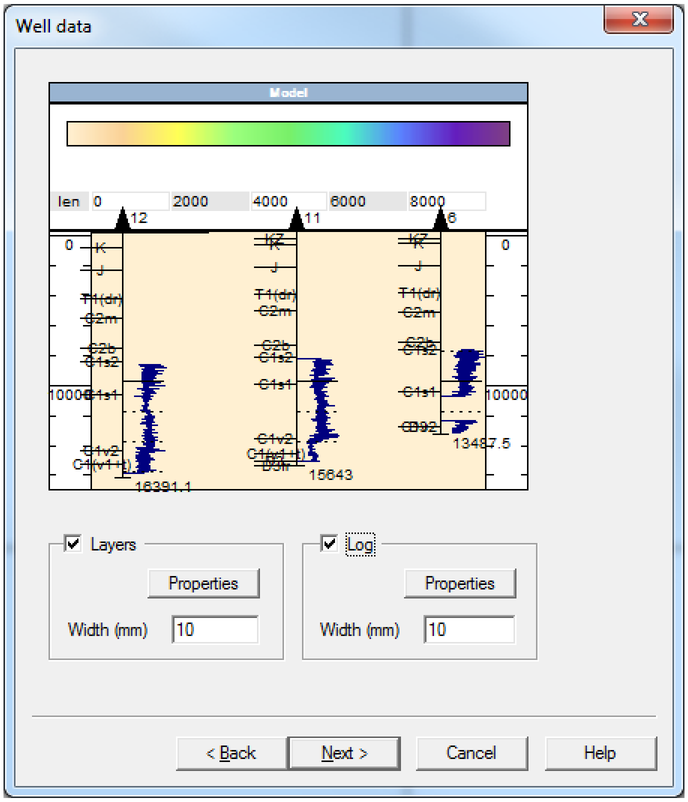

Base Polygon
Model
len 0 2000 4000 6000 8000
12
11
6
0
10000
16391.1
15643
13487.5
< Back
Next >
Cancel
Help

Compressional velocity 7000 ft/s

☐ Vertical linear velocity gradient (V=A+Depth*B)

V = 0 + Depth * 0

In the next dialogue box `Well data`, you may select the stratigraphic arrangements and the logging data will be shown near the wells.


Well data
Model
len
0
2000
4000
6000
8000
12
11
6
10000
K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2
16391.1
15643
13487.5
Properties
Properties
< Back
Next >
Cancel
Help

☑ Layers

Width (mm) 10

☑ Log

Width (mm) 10

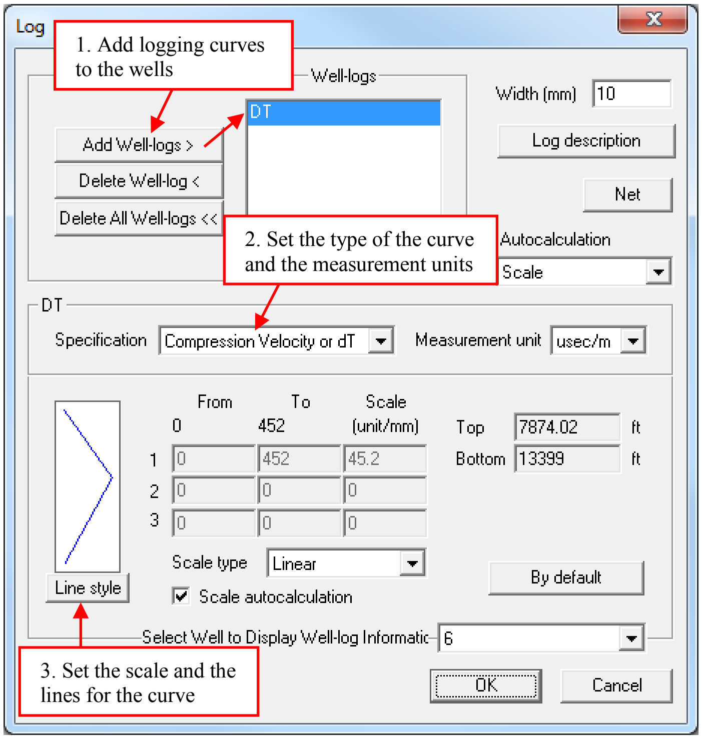
Check `Layers` for automatic creation of polygons by stratigraphic correspondences. Check `Log` for automatically filling the polygons with the parameters from well logging (creation of thin-layered model).

Preparation for creating a thin-layered model

The preparation includes selecting curves for the model and adjusting the re-calculation parameters and the well logging data to characterize the polygons (velocity, density, fracturing, anisotropy).

> **NOTE:** If `Log` is checked, then the acoustic logging curves will appear to the right of the well, and the parameters for re-calculating these curves are set automatically. If the logging curves do not appear, it is recommended to go to the dialogue box `Log` by clicking the corresponding button `Properties`.

In the dialogue `Log`, please select the acoustic logging curves (DT or acoustic logging) from the list of the curves for the model's wells. For further filling-in of the polygon parameters from the logging data, for the selected curves, please set `Specification` to `Compressional Velocity or dT` and also `Measure unit` to `usec/m` in order to re-calculate the parameters of the polygons from the curves' values correctly.


Log
Add Well-logs >
Delete Well-log <
Delete All Well-logs <<
Log description
Net
By default
Line style
OK
Cancel

1. Add logging curves to the wells

2. Set the type of the curve and the measurement units

3. Set the scale and the lines for the curve

Well-logs: DT

Width (mm) 10

Autocalculation: Scale

DT

Specification: Compression Velocity or dT

Measurement unit: usec/m

	From	To	Scale (unit/mm)
	0	452	
1	0	452	45.2
2	0	0	0
3	0	0	0

Top 7874.02 ft

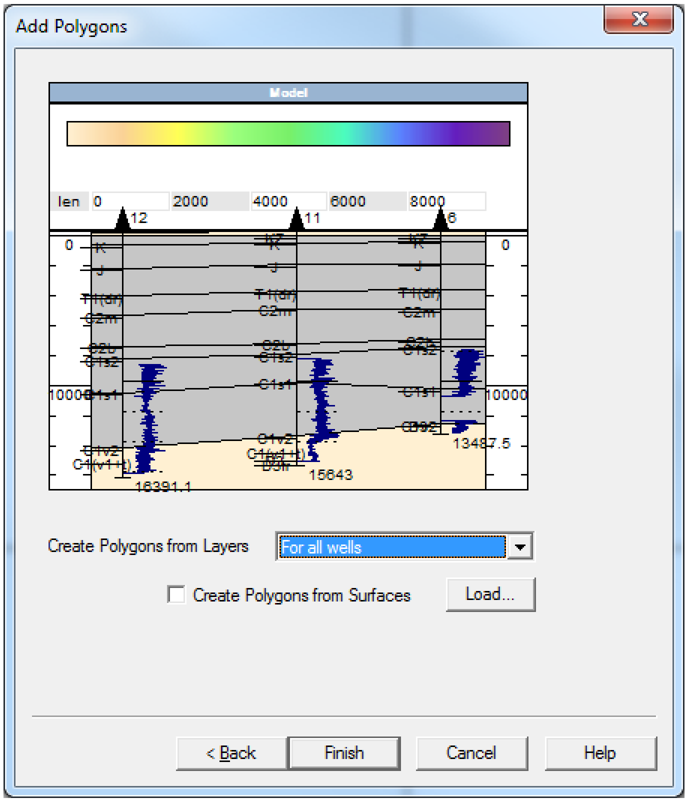
Bottom 13399 ft

Scale type: Linear

☑ Scale autocalculation

Select Well to Display Well-log Informatic: 6

Then press OK and the Log dialogue box will close. As the result, in the Well data dialogue, the logging curves should appear near the wells. Press the Next > button to go to the next dialogue box Add polygons.


Add Polygons
Model
len
0
2000
4000
6000
8000
12
11
6
0
10000
K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2
C1(v1+t)
16391.1
15643
13487.5
Load...
< Back
Finish
Cancel
Help

Create Polygons from Layers: For all wells

☐ Create Polygons from Surfaces

In the dialogue box Add Polygons, from the drop-down list Create Polygons from Layers, the following options are available for the creation of polygons:

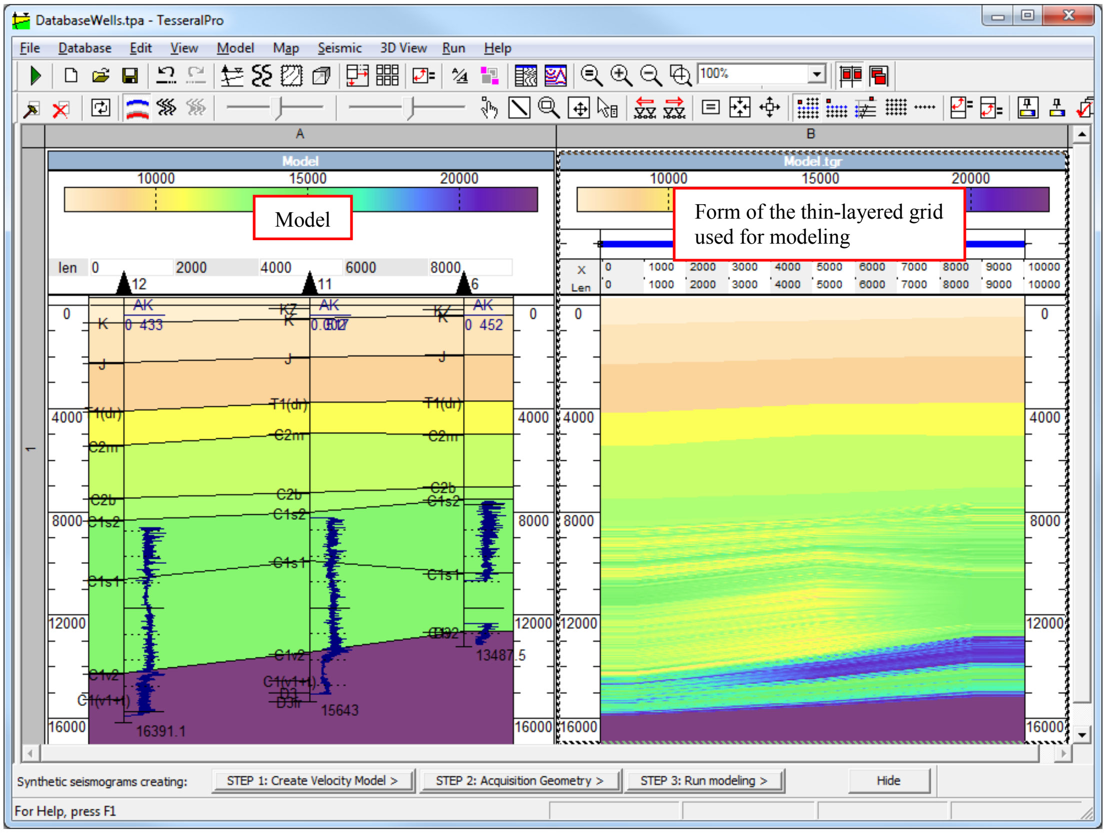
- No – do not create the polygons automatically

- `All layers` – to create the polygons for all the layers which exist *at least in one* of the selected wells. It means that, if the layer exists in any of the selected wells, it will be used for the creation of polygons.
- `For all wells` – create polygons for the layers which exist in *all the selected* wells. As a special case, if a layer is not present at least in one of the selected wells, it will not be used for creation of polygons.
- `Selected` – select the layers manually from the list of the layers in the database.

Check `Create Polygons from Surfaces` to create the polygons using the previously loaded surfaces. In this dialogue box, users can load the surfaces by clicking the button `Load`.

As a result, the model will be created in which the velocities (and/or) other parameters will be obtained automatically from well logging data. However, as mentioned above, users need to load in advance the databases: coordinates of the wells, coordinates of layers' intersections and the logging curves (please see the Section *17.5* for more details).

The parameters interpolated by logging data (thin-layering) are not shown in the polygons. The interpolation is done automatically before the modeling job is launched. You may QC the quality of the final model by using `Model > Export to Seismic Format (SEG-Y, TGR` menu item to export the velocity model to a grid file.


DatabaseWells.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
B
Model
Model.tgr
10000 15000 20000
len 0 2000 4000 6000 8000
X Len 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
12 11 6
AK
K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2
C1(v1+t)
D3fr
0 433
0 452
0 4000 8000 12000 16000
16391.1
15643
13487.5
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

Model

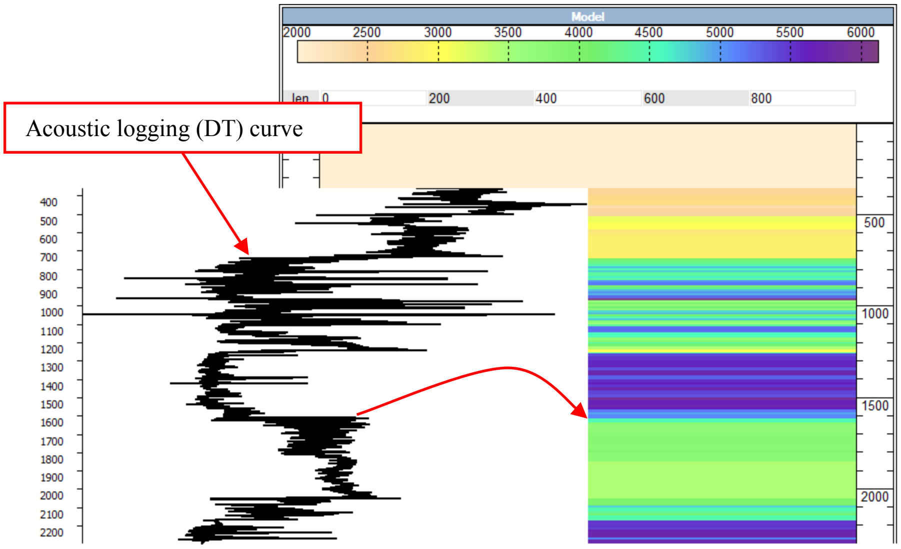
Form of the thin-layered grid used for modeling

> NOTE: This grid file is not used in actual calculations. It is used only for QC/visualizing the final model to be used in modeling.

In the Tesseral Pro, some special tools are implemented for creating and adjusting polygons whose properties are derived from well data. Please see Section *5.9* for more details. By building polygons from well data, thin-layer models are created.

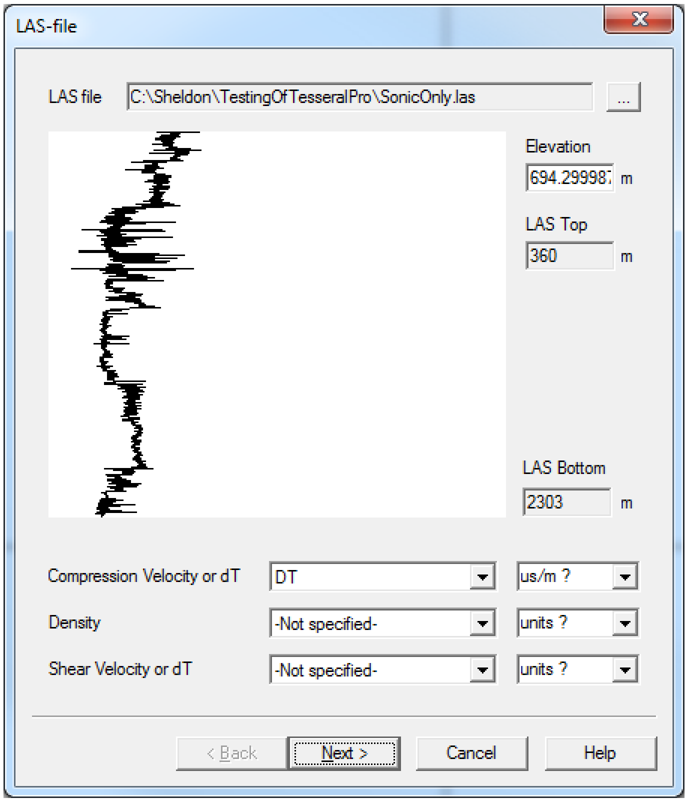
4.6 Creation of a simple flat layered model from LAS file

In this section, a simple method is described for creating a model from acoustic logging data and/or density measurement data without loading the data in advance into database.



Acoustic logging (DT) curve

To start this functionality, first click `Model > Create Velocity Model (New Frame)`, then in the dialogue box `Create new Model` click the button `From LAS-file >`. In the dialogue box LAS-file, select the LAS-file containing the velocity and/or density.



LAS-file

LAS file: C:\Sheldon\TestingOfTesseralPro\SonicOnly.las

Elevation: 694.29998 m

LAS Top: 360 m

LAS Bottom: 2303 m

Compression Velocity or dT: DT, us/m ?

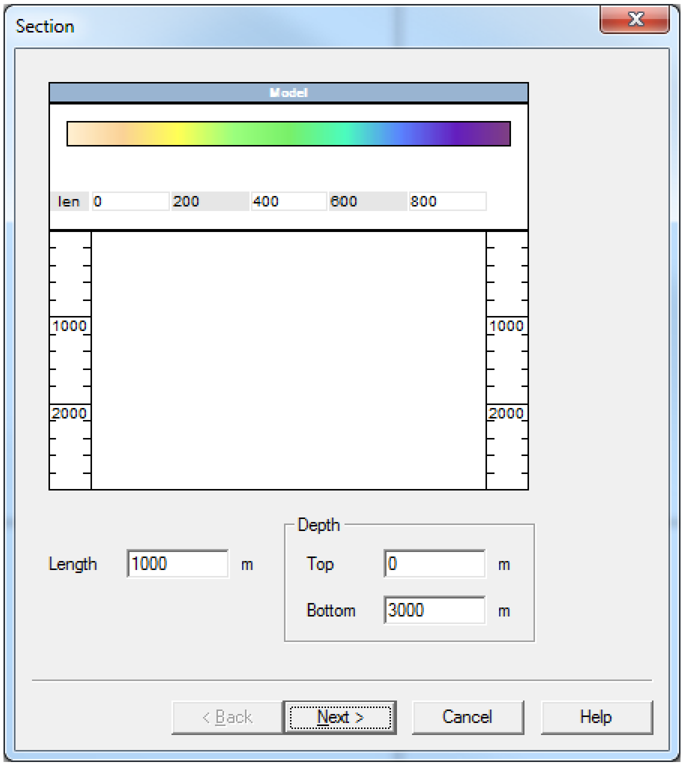
Density: -Not specified-, units ?

Shear Velocity or dT: -Not specified-, units ?

In the dialogue box `LAS-file`, select the curve corresponding to the component of the model Compressional Velocity or dT, Density, Shear Velocity or dT, and then select the units of measurement for each component.

It is also recommended to set the well altitude (`Elevation`) correctly. The directionality of log data is not used for creating horizontally-layered models. However, it will not be enough to have only altitudes for conventionally vertical wells.

In the next dialogue box `Section`, specify the length and the model's depth range:

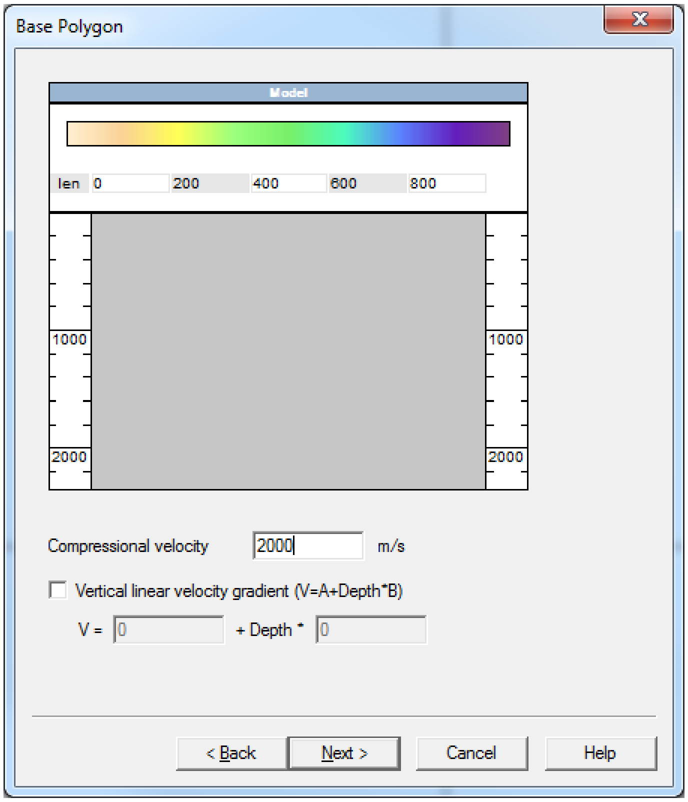

Section
Model
len
0
200
400
600
800
1000
2000
1000
2000
Depth
< Back
Next >
Cancel
Help

Length 1000 m

Top 0 m

Bottom 3000 m

Then specify the velocity for the basic polygon.


Base Polygon
Model
len
0
200
400
600
800
1000
2000
1000
2000
< Back
Next >
Cancel
Help

Compressional velocity 2000 m/s

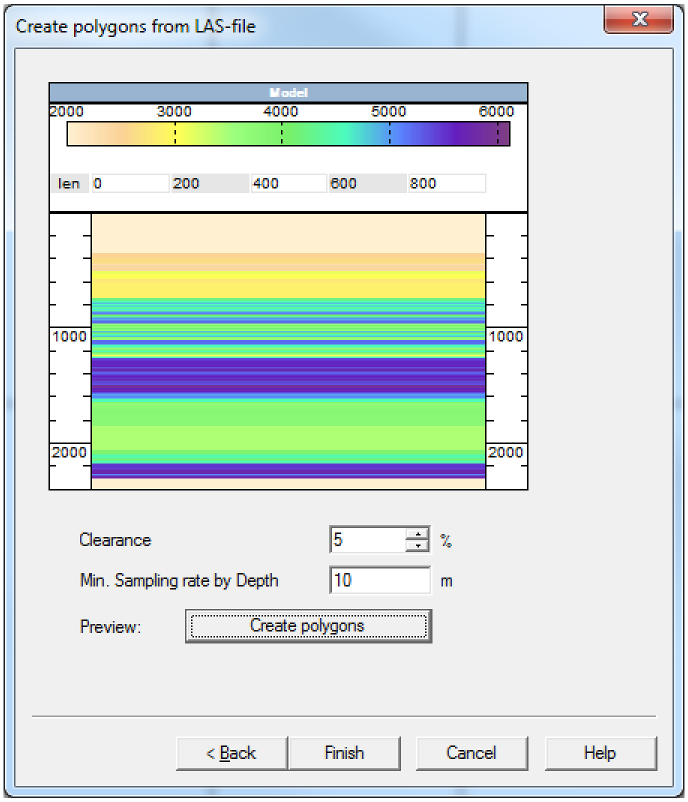
☐ Vertical linear velocity gradient (V=A+Depth*B)

V = 0 + Depth * 0

In the last dialogue box `Create polygons from LAS-file`, specify the parameters which will be used for building a thin-layered model. These parameters determine the number and the thickness of the polygons created automatically from the LAS-file.

`Clearance` is the maximally allowed velocity variation within a polygon.

`Min. Sampling rate by Depth` is the minimum thickness of a polygon.



Create polygons from LAS-file

Clearance 5 %

Min. Sampling rate by Depth 10 m

Model
2000
3000
4000
5000
6000
len
0
200
400
600
800
1000
2000
1000
2000
Preview:
Create polygons
< Back
Finish
Cancel
Help

For models built from well data, the polygons are filled by the interpolated parameters from the wells. If only LAS-file is used for model building, numerous thin polygons are created. To check the quality of the specified parameters, press the button `Create polygons`. Feel free to play with the parameters if you do not like the results.

4.7 Creation of a model from SPS-file

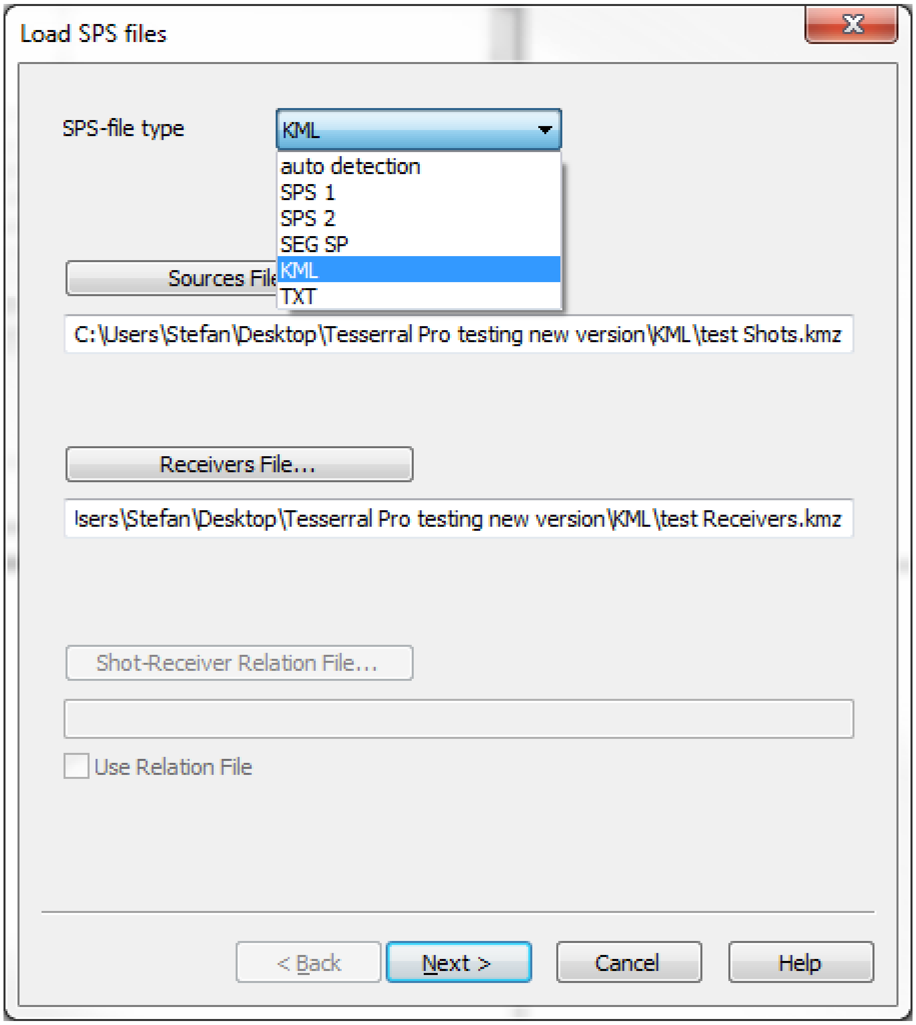
If you want to reproduce a field acquisition geometry while creating synthetic gathers and design the model surface using the real altitudes of sources and receivers, it is recommended to use an SPS-file to create the new model.

> NOTE: The SPS-files may be also used only for reproducing the acquisition geometry in a created model. Please see details in the Section *6.7*.

To use this feature, click `Model > Create Velocity Model (New Frame)`. Then, in the dialogue box `Create new Model` press the button `From SPS-file >`.

Then in the dialogue box `Load SPS files`, select the files of sources, receivers and their acquisition geometry.

Also, please note that SPS scripts of all types are supported, as well as SEG scripts, KML (KMZ), and TXT file (with the following simple format: SrcX, SrcY, SrcZ, RcvX, RcvY ,RcvZ)



Load SPS files
auto detection
SPS 1
SPS 2
SEG SP
KML
TXT
Sources File...
Receivers File...
Shot-Receiver Relation File...
< Back
Next >
Cancel
Help

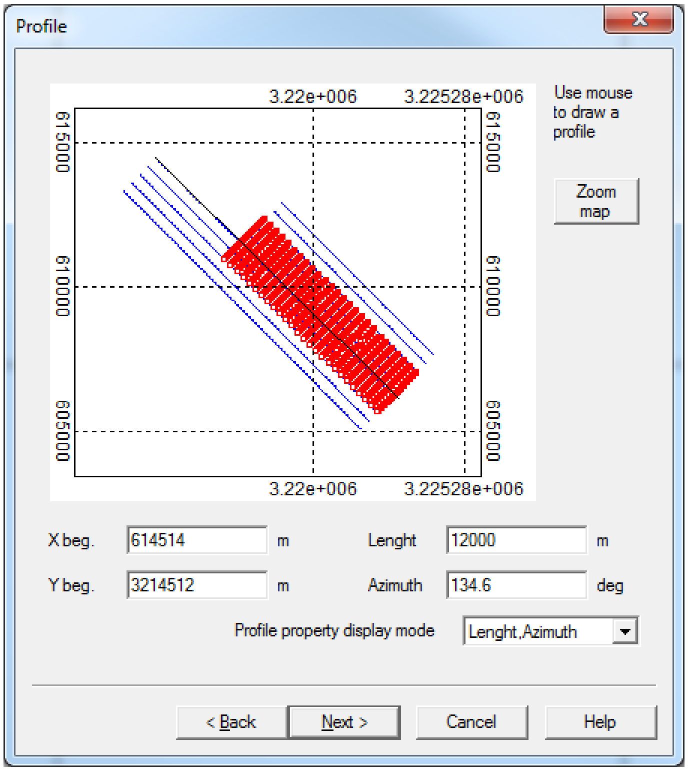
SPS-file type: KML

C:\Users\Stefan\Desktop\Tesserral Pro testing new version\KML\test Shots.kmz

Isers\Stefan\Desktop\Tesserral Pro testing new version\KML\test Receivers.kmz

☐ Use Relation File

After specifying and loading the correct SPS file type, click `Next` and in the dialogue box `Profile`, specify the model profile:


Profile
3.22e+006
3.22528e+006
615000
610000
605000
Use mouse to draw a profile
Zoom map
< Back
Next >
Cancel
Help

X beg. 614514 m

Y beg. 3214512 m

Lenght 12000 m

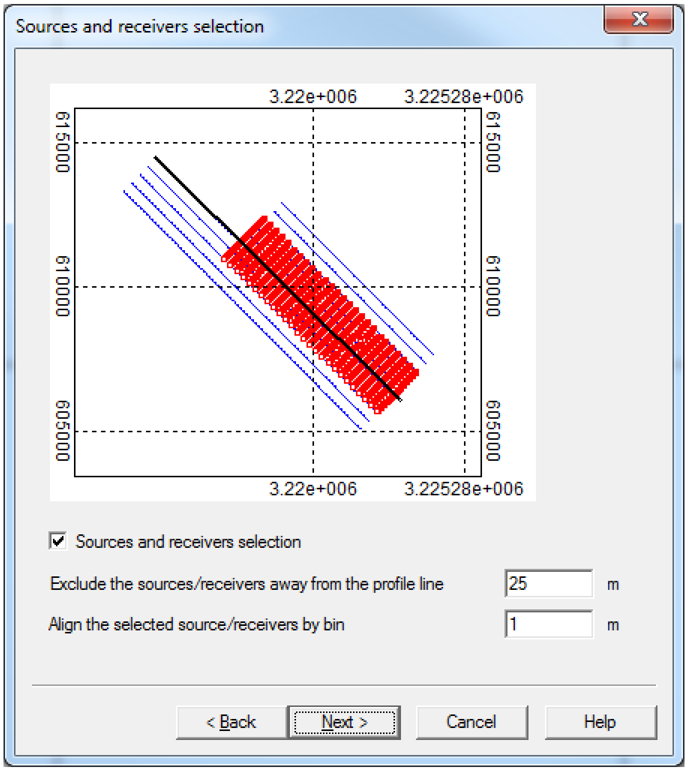
Azimuth 134.6 deg

Profile property display mode Lenght,Azimuth

In the figure above, the red rectangles indicate the sources, and the blue dots indicate the receivers. Please note that it is only possible to build 2D models in the Tesseral Pro, and so only the sources and the receivers close to the selected profile will be included.

To select the profile coordinates more accurately, please use the button `Zoom map`.

In the next dialogue box `Sources and receivers selection`, specify the parameters used for selecting the sources and receivers and binning the selected sources/receivers. This dialogue box is needed for proper extraction of needed sources and receivers from the loaded 3D acquisition geometry.


Sources and receivers selection
3.22e+006
3.22528e+006
615000
610000
605000
< Back
Next >
Cancel
Help

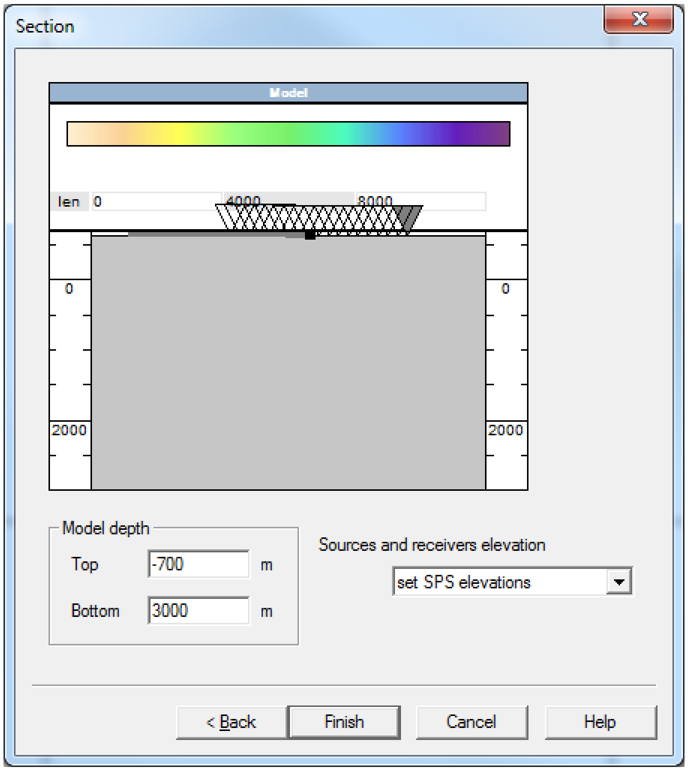
☑ Sources and receivers selection

Exclude the sources/receivers away from the profile line 25 m

Align the selected source/receivers by bin 1 m

Then in the next dialogue box `Section`, specify the depth range of the model and how to use the altitudes of the sources and receivers saved in the SPS-files (the parameter `Sources and receivers elevation`):

- `set SPS elevations`: the top of the basic polygon that is to be built by the altitudes of sources and receivers.
- `move under model top`: the sources and the receivers are moved to the models' top
- `ignore`: the basic polygon of the model and the altitudes of the sources and the receivers are assigned independently.


Section
Model
len
0
4000
8000
0
2000
0
2000
< Back
Finish
Cancel
Help

Model depth

Top -700 m

Bottom 3000 m

Sources and receivers elevation: set SPS elevations

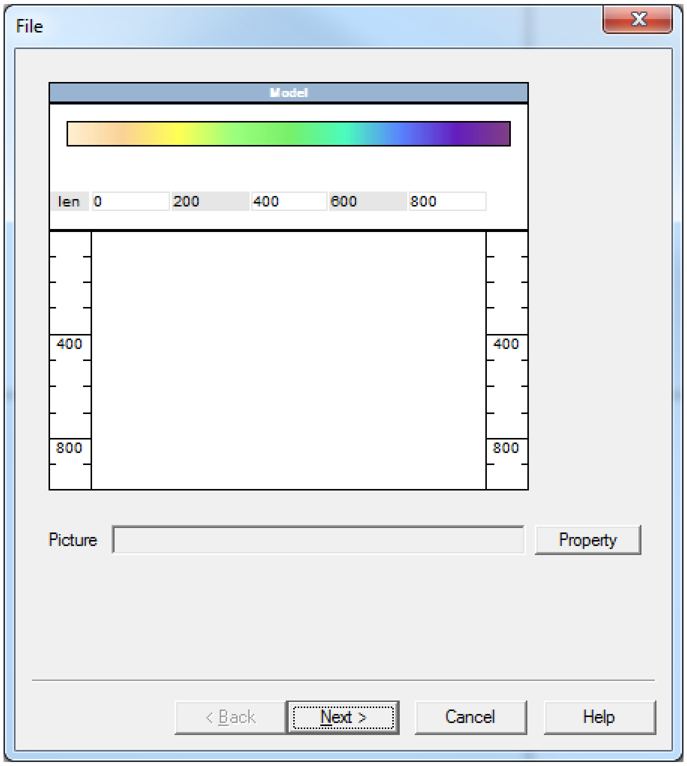
As in other model creation methods, users need to fill in the obtained model with polygons (please see details in the Section *4.11*).

4.8 Creation of a model from PICTURE

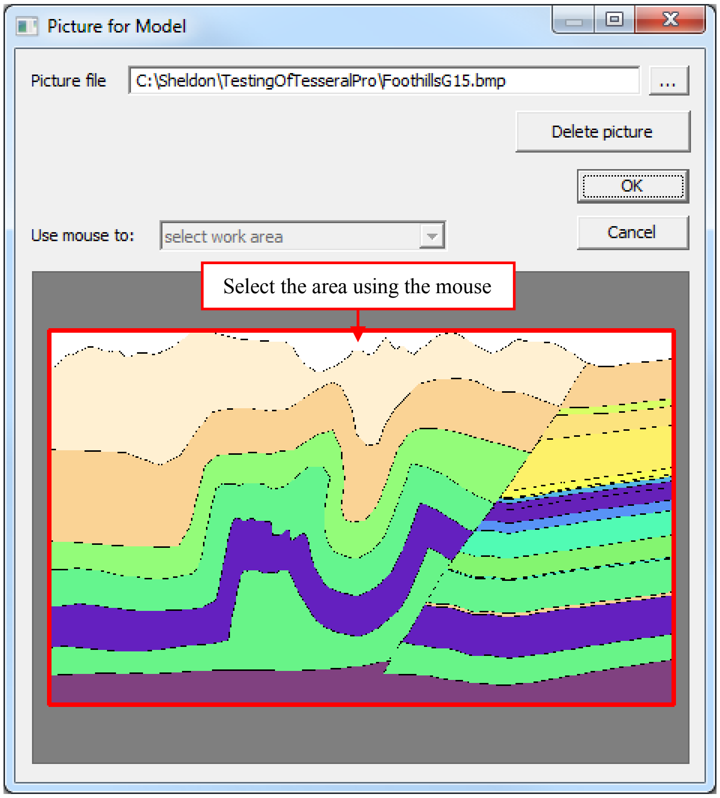
This method is used for drawing model polygons manually from the underlying picture.

To use this option, click `Model > Create Velocity Model (New Frame)`. In the dialogue box `Create new Model`, press the button `From Picture >`.

Then in the next dialogue box, select the underlying picture in a BMP, JPEG, TIFF, GEO-TIFF, GEO-JPEG format pictures with coordinates in TFW, JGW files, by clicking the button `Property`.


File
Model
len
0
200
400
600
800
400
800
400
800
Picture
Property
< Back
Next >
Cancel
Help

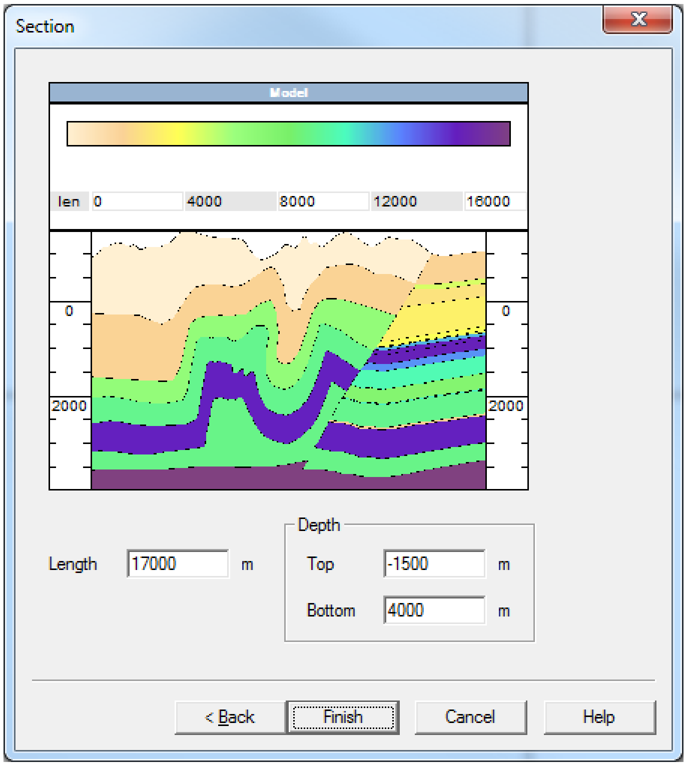
In the dialogue box `Picture for Model`, select the file of the picture and the area (part) of the picture, which will be used as an underlying image in the Frame Model.


Picture for Model
...
Delete picture
OK
Cancel
Select the area using the mouse

Picture file: C:\Sheldon\TestingOfTesseralPro\FoothillsG15.bmp

Use mouse to: select work area

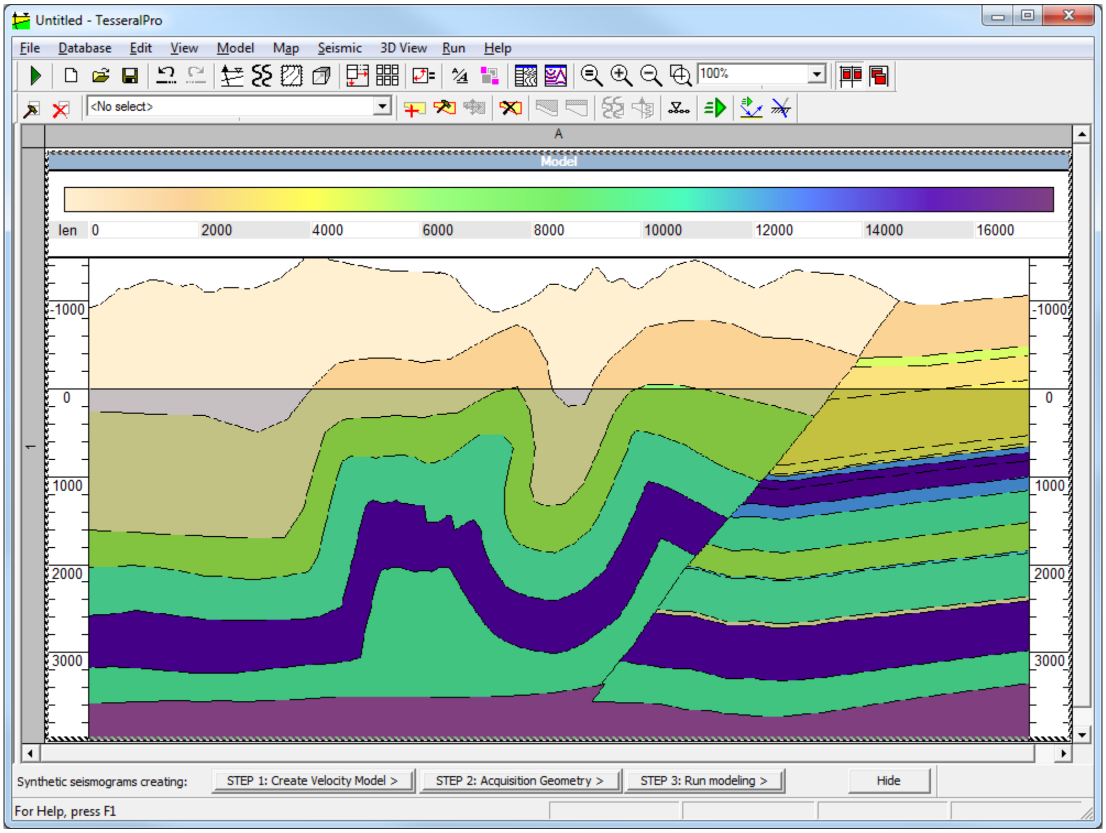
Then in the next dialogue box `Section`, specify the depth range and the length of the model.


Section
Model
len
0
4000
8000
12000
16000
0
2000
0
2000
Depth
< Back
Finish
Cancel
Help

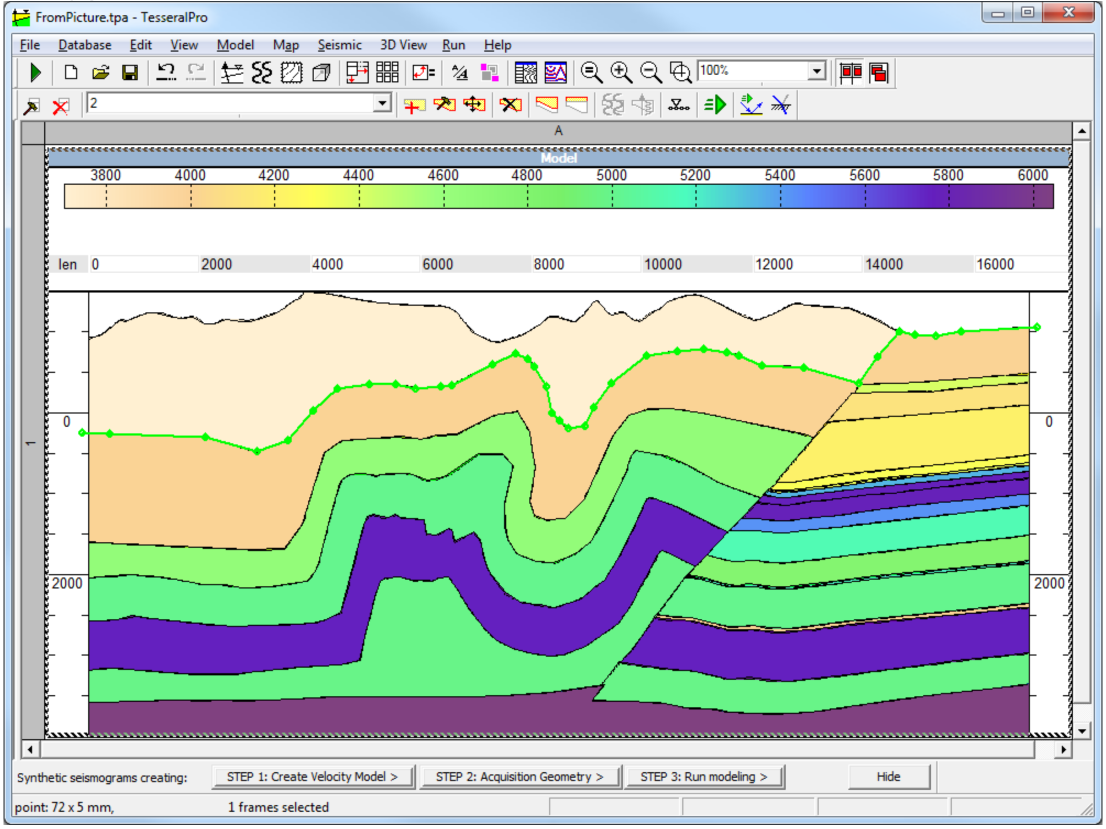
Length: 17000 m

Depth: Top -1500 m, Bottom 4000 m

After that, the Frame Model with the underlying picture will be created, as shown below.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
<No select>
A
Model
len 0 2000 4000 6000 8000 10000 12000 14000 16000
-1000
0
1000
2000
3000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

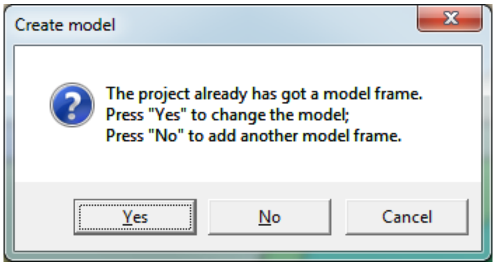
This underlying picture cannot be used for modeling, but the polygons may be drawn manually by following the visible boundaries, and then velocity and other parameters for the created polygons need to be specified.


FromPicture.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
2
A
Model
3800 4000 4200 4400 4600 4800 5000 5200 5400 5600 5800 6000
len 0 2000 4000 6000 8000 10000 12000 14000 16000
0
2000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 72 x 5 mm,
1 frames selected

Here is the final result of modeling using raster image.

4.9 Hybrid method for model creation

You may create a model by using a SPS file, surfaces, a gather for the velocity model and well data simultaneously. At first, users need to create an initial model using any of the methods. Then choose the model creation command `Model > Create Velocity Model (New Frame)` again. You will be asked whether you would like to change the existing model or create a new one. Select `Yes` to use the other model creation method in order to change the model.



The project already has got a model frame.
Press "Yes" to change the model;
Press "No" to add another model frame.

4.10 Load model in other formats

Use the command `Model > Create Velocity Model (New Frame)`, and then in the dialogue box `Create new Model`, click the button `Load model from other format file`.

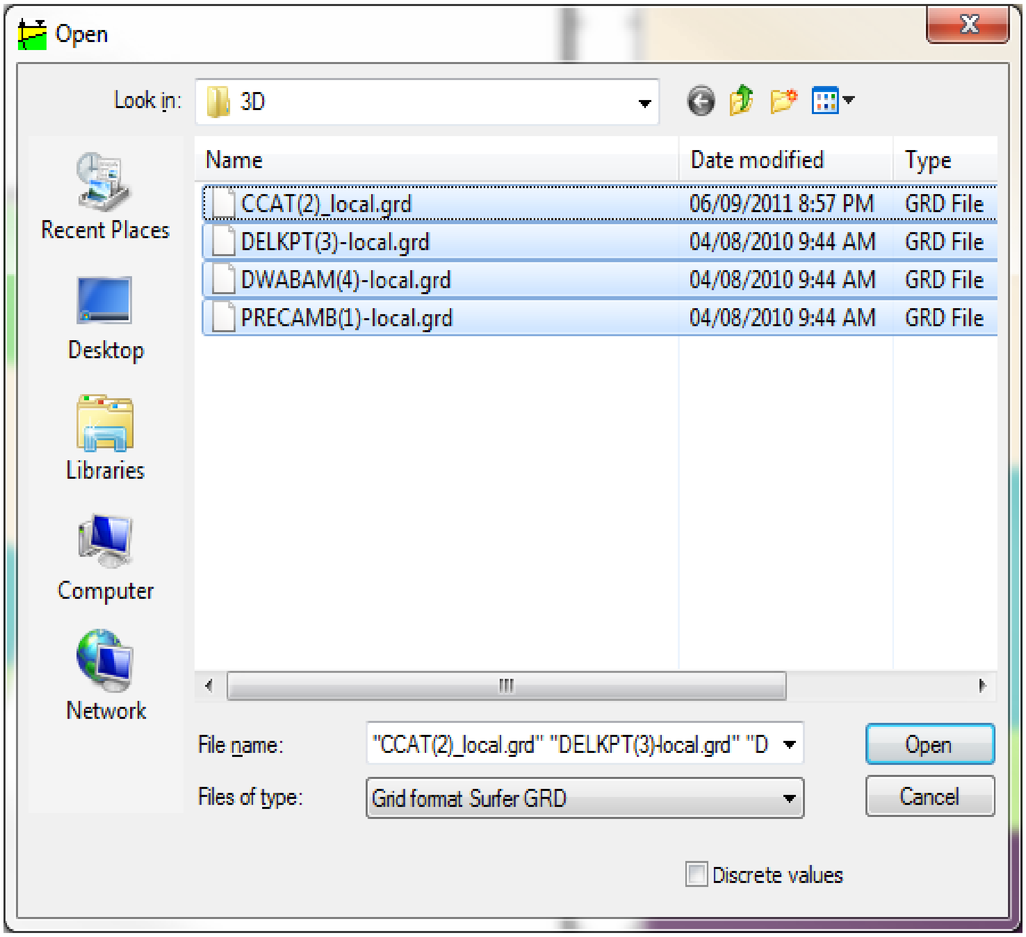
The supported formats include TAM (model format from the Tesseral 2D package), WGC, GXII and table text files. Surely, users can also load a model from another project (TPA format).

4.11 3D Model building from Surfaces

Load all surfaces you want to use for 3D model building by going `Map > Create Map (New Frame) > Load TXT or GRD- surface files`

For instructions on how to load or create surfaces from XYZ text files, please follow the instructions from Section *14*

Select the surfaces you want to use as horizons:


Open
Recent Places
Desktop
Libraries
Computer
Network
Open
Cancel
☐ Discrete values

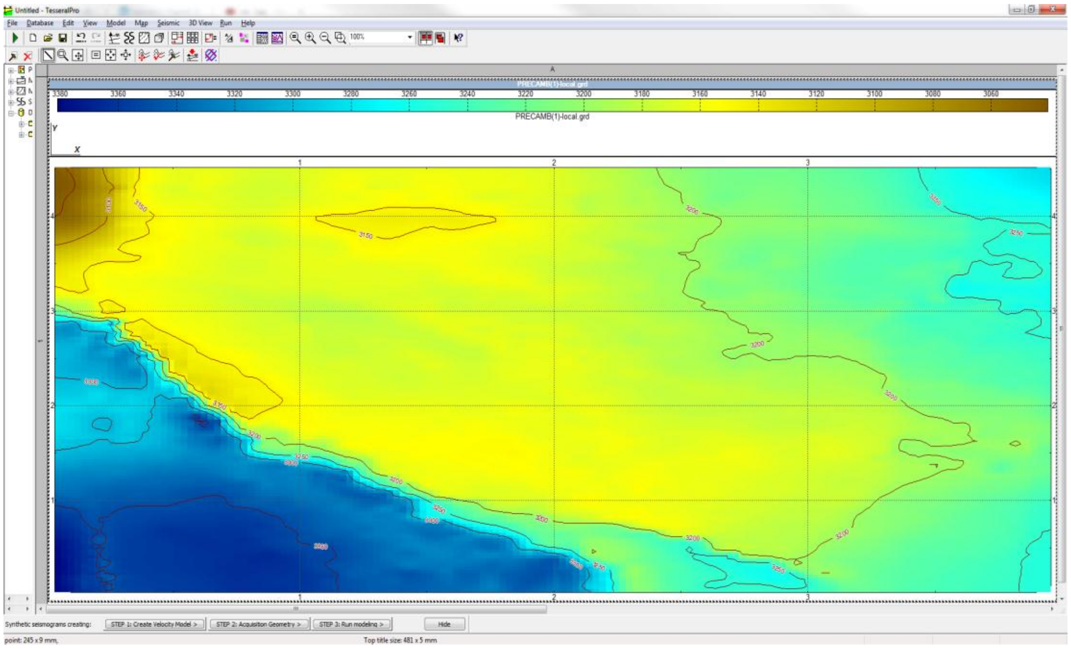
Look in: 3D

Name	Date modified	Type
CCAT(2)_local.grd	06/09/2011 8:57 PM	GRD File
DELKPT(3)-local.grd	04/08/2010 9:44 AM	GRD File
DWABAM(4)-local.grd	04/08/2010 9:44 AM	GRD File
PRECAMB(1)-local.grd	04/08/2010 9:44 AM	GRD File

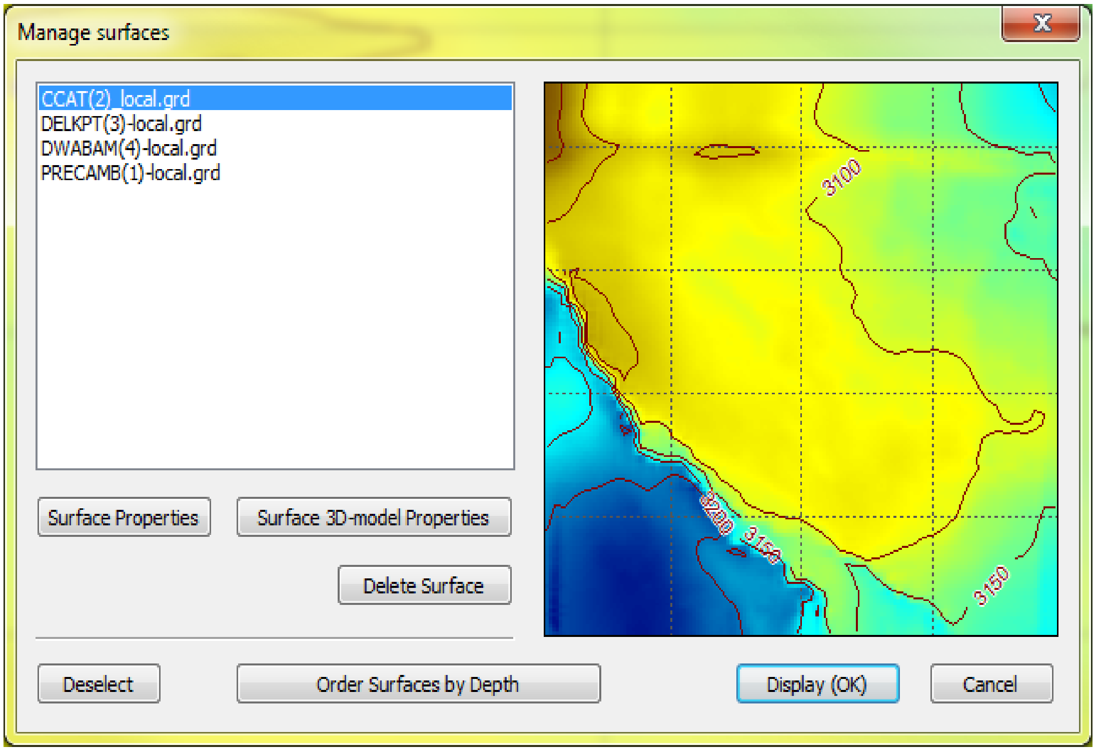
File name: "CCAT(2)_local.grd" "DELKPT(3)-local.grd" "D

Files of type: Grid format Surfer GRD

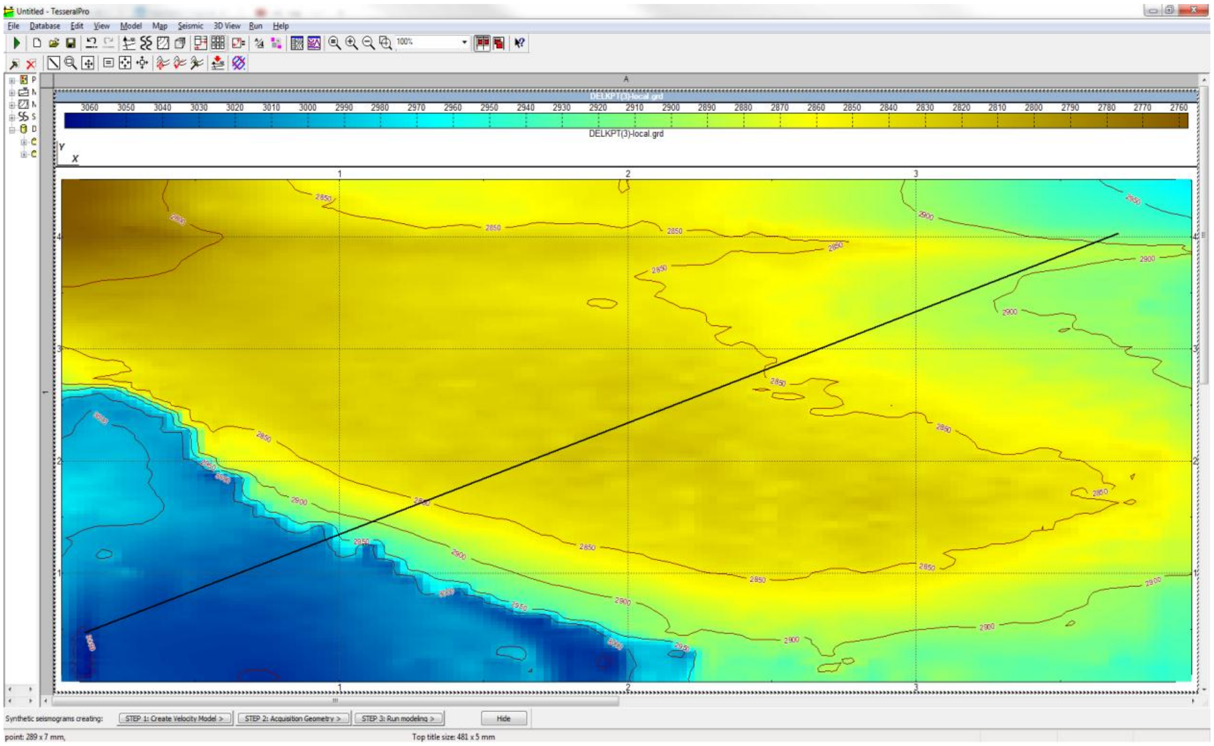
This is the uppermost surface:


PRECAMB(1)-local.grd

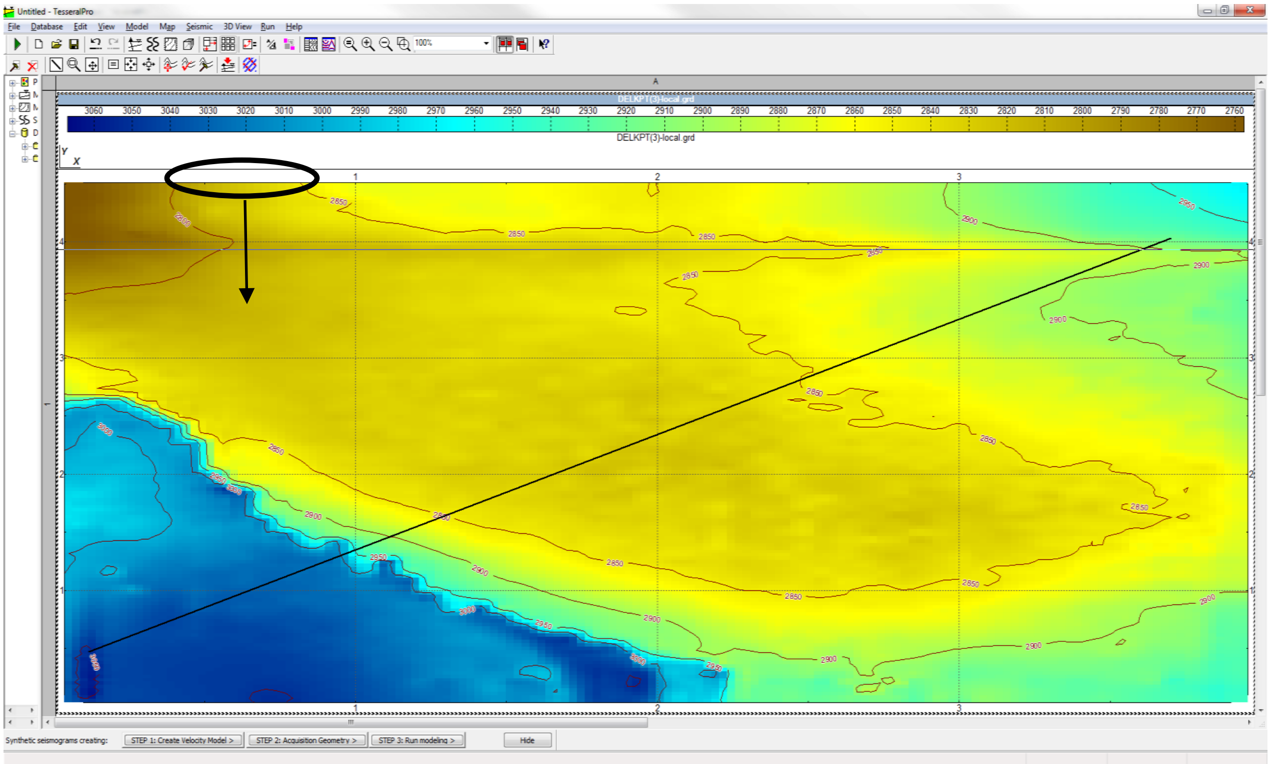
You can manage and view all surfaces individually by going `Map > Manage/ Delete surfaces`.

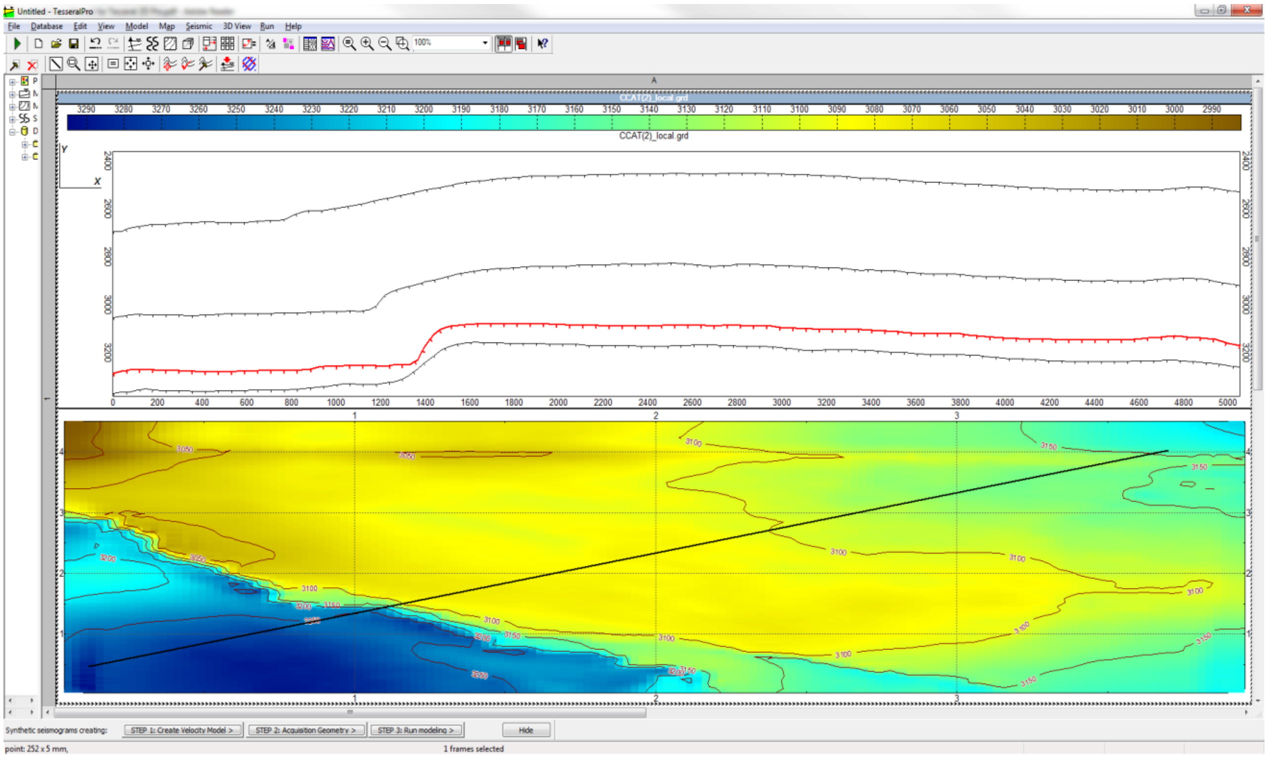

Manage surfaces
CCAT(2)_local.grd
DELKPT(3)-local.grd
DWABAM(4)-local.grd
PRECAMB(1)-local.grd
Surface Properties
Surface 3D-model Properties
Delete Surface
Deselect
Order Surfaces by Depth
Display (OK)
Cancel
3100
3200
3150
3150

Once all surfaces have been loaded, values must be introduced for all layers created by these surfaces. In order to do that, a 2D cross-section needs to be generated first. This is done by accessing `Map > Section Mode` and drawing the profile on the surface, by pressing-dragging-releasing the left mouse button.

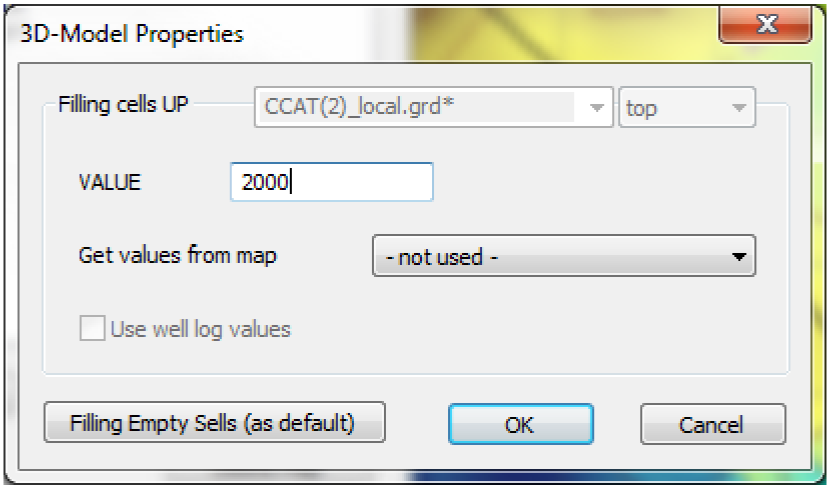

Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
DELKPT(3)-local.grd
3060 3050 3040 3030 3020 3010 3000 2990 2980 2970 2960 2950 2940 2930 2920 2910 2900 2890 2880 2870 2860 2850 2840 2830 2820 2810 2800 2790 2780 2770 2760
Y
X
1
2
3
2850
2900
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 289 x 7 mm,
Top title size: 481 x 5 mm

In order to see the cross section you need to bring down the (encircled) lower header:
This is done by left clicking on the lower header and then dragging it down with the left mouse button.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
DELKPT(3)-local.grd
3060 3050 3040 3030 3020 3010 3000 2990 2980 2970 2960 2950 2940 2930 2920 2910 2900 2890 2880 2870 2860 2850 2840 2830 2820 2810 2800 2790 2780 2770 2760
2850
2900
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
CCAT(2)_local.grd
3290 3280 3270 3260 3250 3240 3230 3220 3210 3200 3190 3180 3170 3160 3150 3140 3130 3120 3110 3100 3090 3080 3070 3060 3050 3040 3030 3020 3010 3000 2990
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000
3100
3150
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 252 x 5 mm,
1 frames selected

To assign a value (i.e. compressional velocity, shear velocity, density etc.) to a particular layer click on `Map > Manage/ Delete Surfaces > Surface 3D-model Properties`.



3D-Model Properties

Filling cells UP: CCAT(2)_local.grd* — top

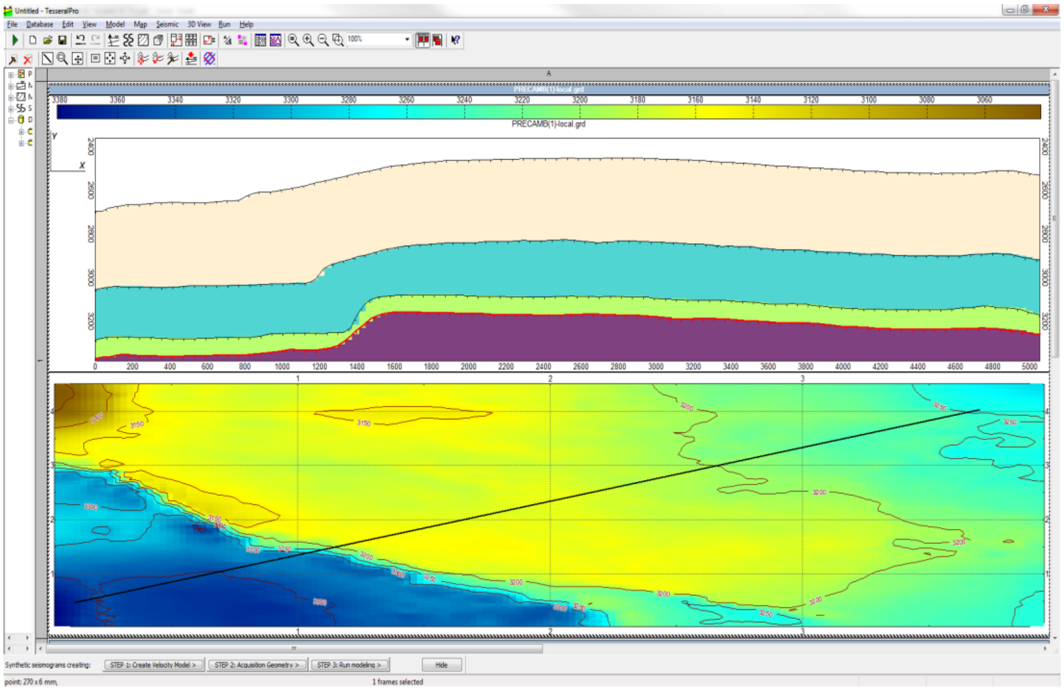
VALUE: 2000

Get values from map: - not used -

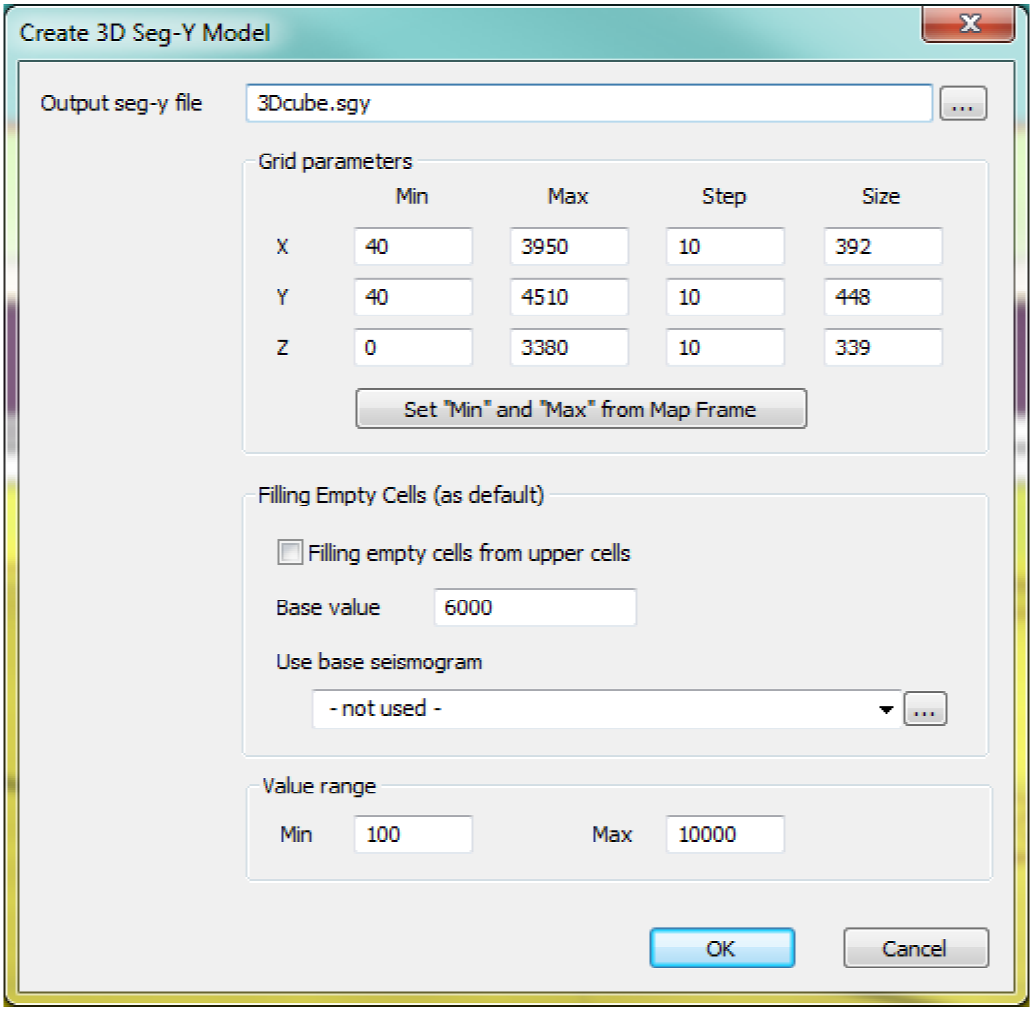
☐ Use well log values

Filling Empty Sells (as default)
OK
Cancel

Depending on whether you want to fill the upper part or the lower part of the surface, you specify `Surface type` **bottom,** or `Surface type` **top** respectively.
Repeat this step for all loaded surfaces. Once completed, void (i.e. unfilled) space will remain in the map frame, since all surfaces can be either `Type: top` or `Type: bottom` and not both.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
PRECAMB(1)-local.grd
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
1 frames selected

Finally to create a 3D SEG-Y file go `Run > Map Frame > Create 3D SEG-Y…`



Output seg-y file: 3Dcube.sgy

Grid parameters

	Min	Max	Step	Size
X	40	3950	10	392
Y	40	4510	10	448
Z	0	3380	10	339

Filling Empty Cells (as default)

☐ Filling empty cells from upper cells

Base value: 6000

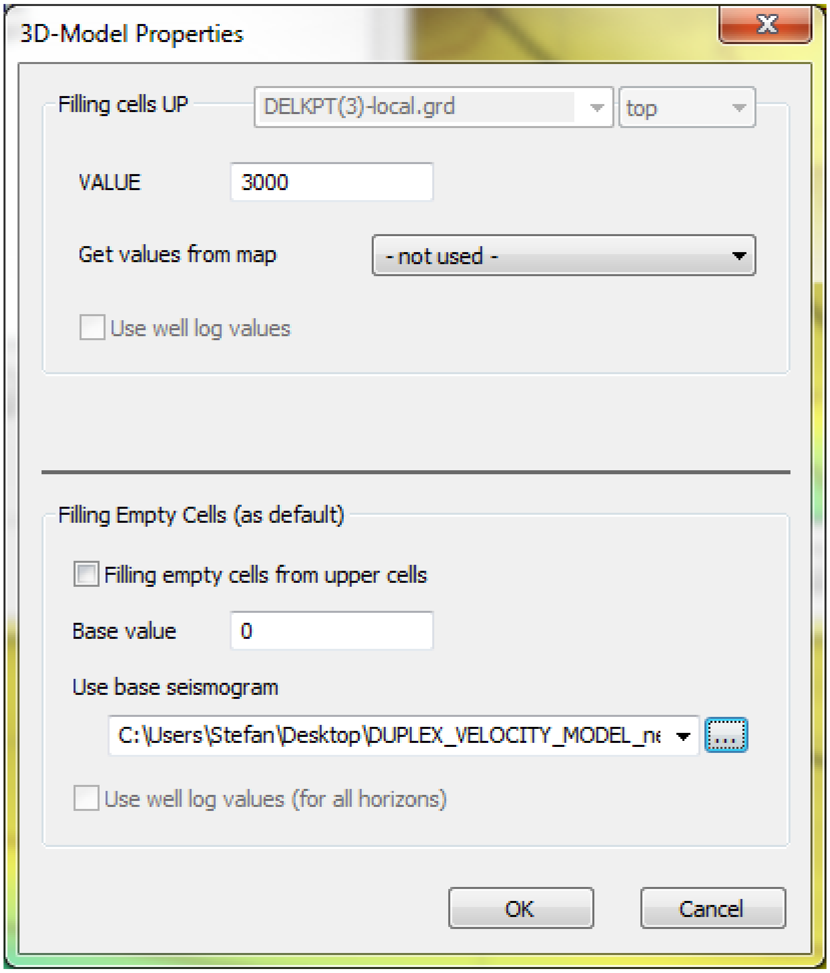
Use base seismogram: - not used -

Value range

Min: 100
Max: 10000

Specify the X, Y, Z dimensions you want for your 3D model, the grid sampling, as well as the `Filling cells` value with which you want to fill the remaining blank layer(s).
If you want to fill the remaining blank layer(s) from a base seismogram (i.e. from 3D SGY cube), then load it in the `Use base seismogram`.

Also, it is possible to fill multiple layers from different base seismograms. In this case these base seismograms are loaded for each surface individually, in the `Map > Manage/ Delete Surfaces > 3D-model Properties>Filling Empty cells(as` `default)>Use base seismogram`.


3D-Model Properties

Filling cells UP: DELKPT(3)-local.grd | top

VALUE: 3000

Get values from map: - not used -

☐ Use well log values

Filling Empty Cells (as default)

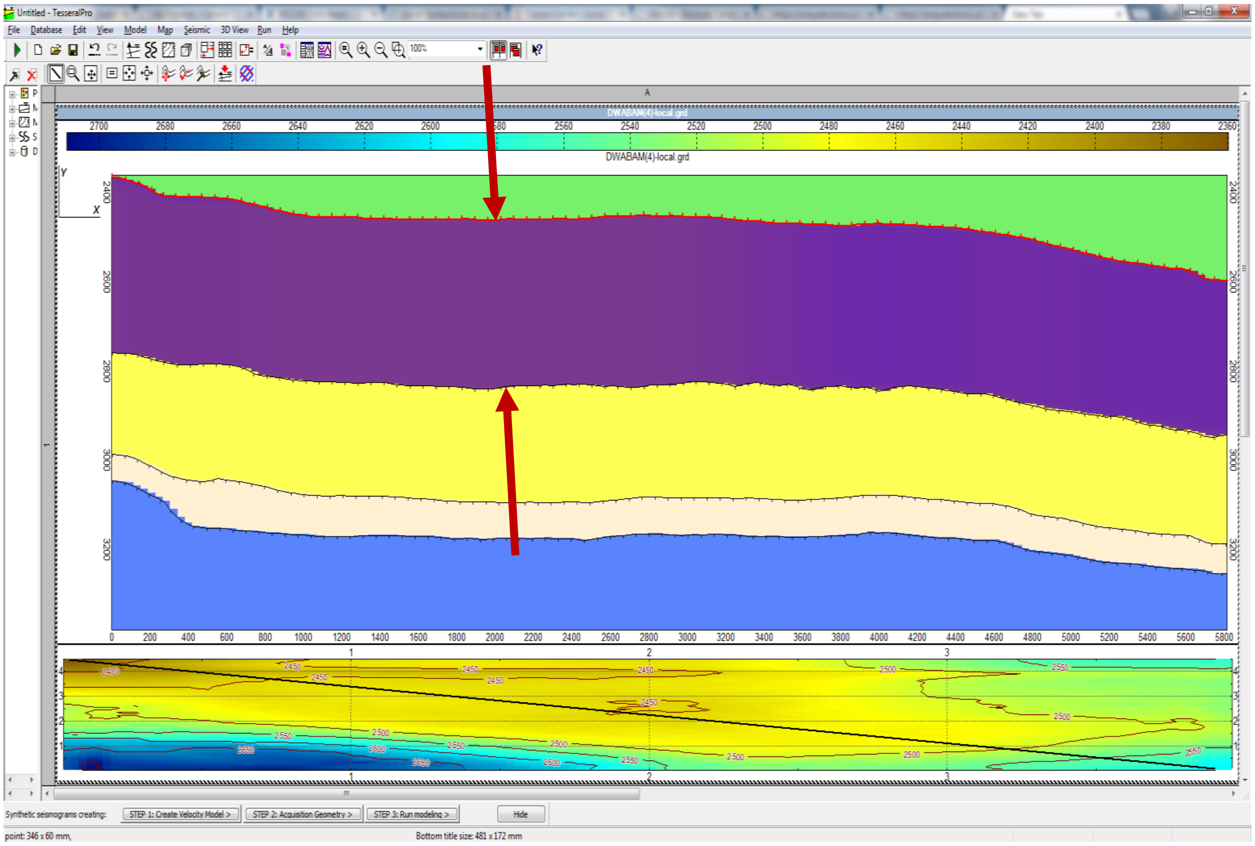
☐ Filling empty cells from upper cells

Base value: 0

Use base seismogram: C:\Users\Stefan\Desktop\DUPLEX_VELOCITY_MODEL_ne

☐ Use well log values (for all horizons)

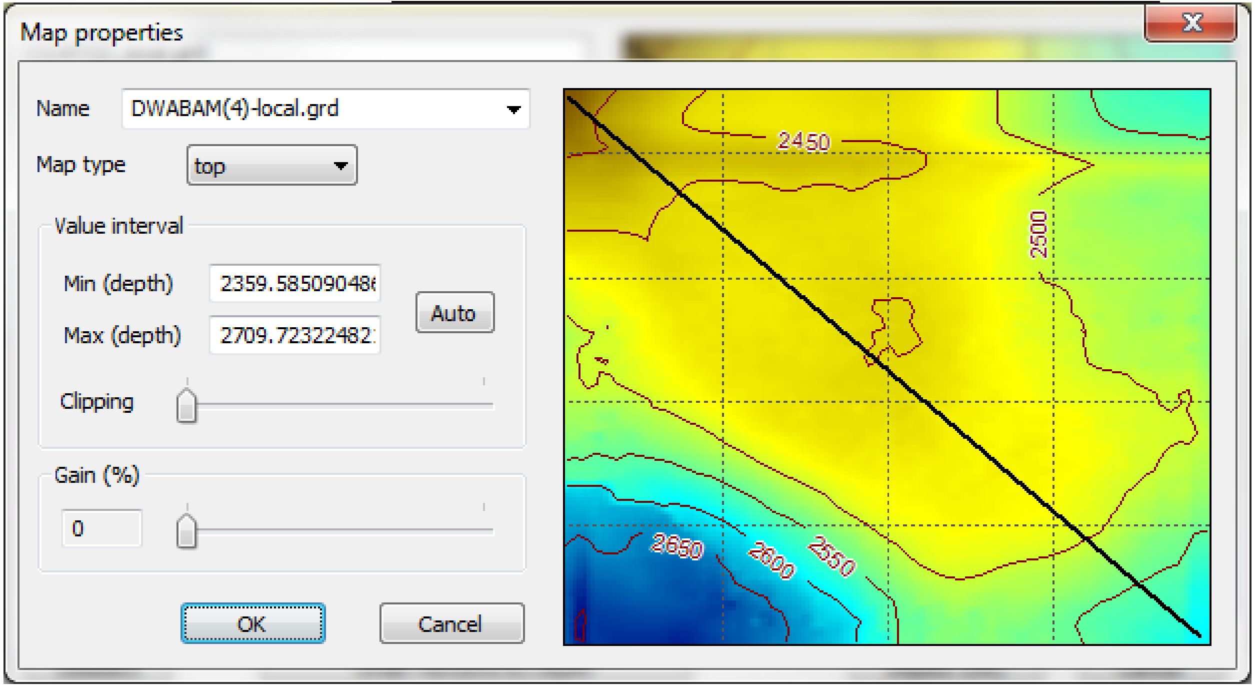
Important note: If a single or several base seismograms were used for building a 3D cube, then the user will notice that after clicking `OK` in the `Run > Map Frame > Create 3D SEG-Y`, the generated 3D SGY cube will NOT contain the assigned base seismogram. Instead, the 3D seismogram will appear in the map frame for the assigned surface. Below you can see the layer extracted from the 3D base cube:


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
DWABAM(4)-local.grd
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 346 x 60 mm,
Bottom title size: 481 x 172 mm

Once you repeat `Run > Map Frame > Create 3D SEG-Y` the second time, the correct cube will be generated. So you can always use the map frame as QC, before generating the cube.

4.11.1 Introducing vertical gradients in 3D cubes

In addition, the user can also introduce horizontal and vertical gradients to any surfaces. To introduce a vertical gradient assign `Map type: Top` and `Map type: bottom` for the upper and lower surfaces respectively, which make up the layer where the gradient is supposed to be introduced. This is done in `Map > Manage/ Delete Surfaces>Properties`



Map properties

Name: DWABAM(4)-local.grd

Map type: top

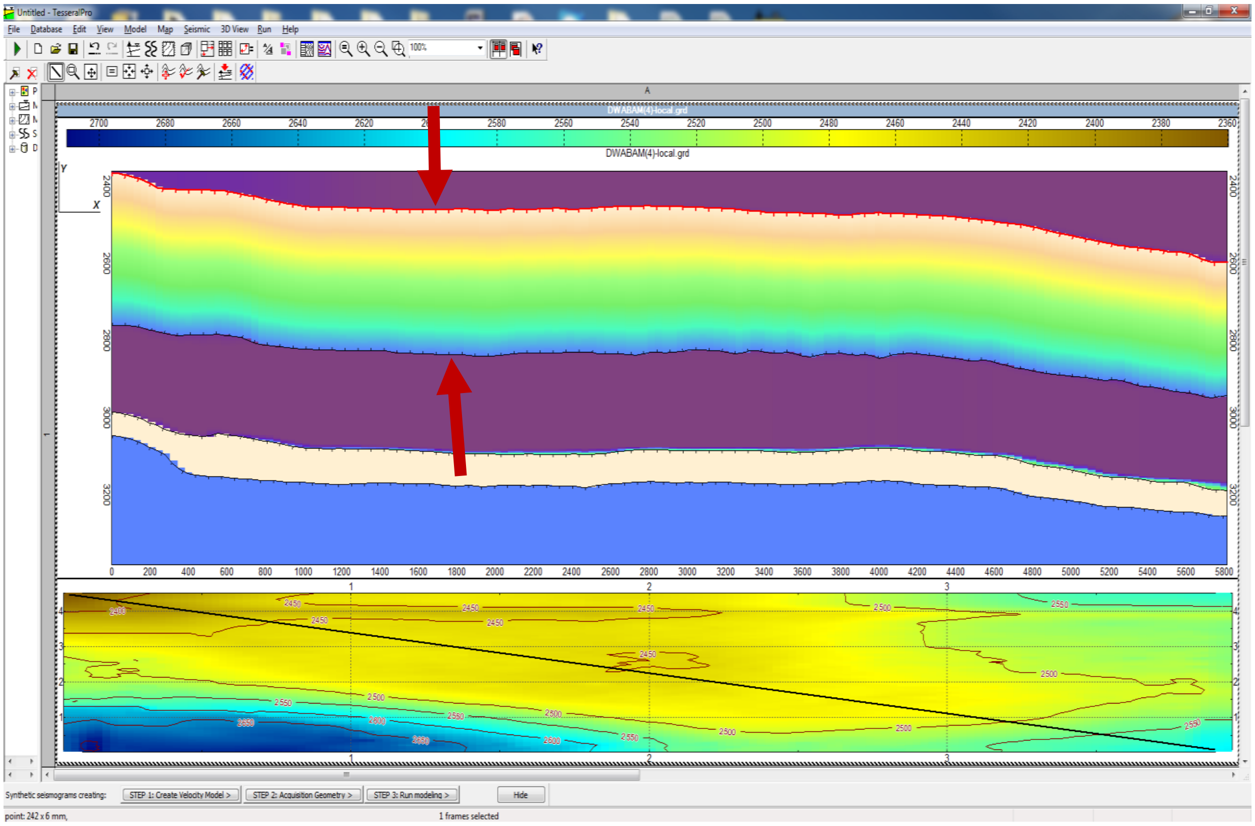
Value interval

Min (depth): 2359.58509048

Max (depth): 2709.72322482

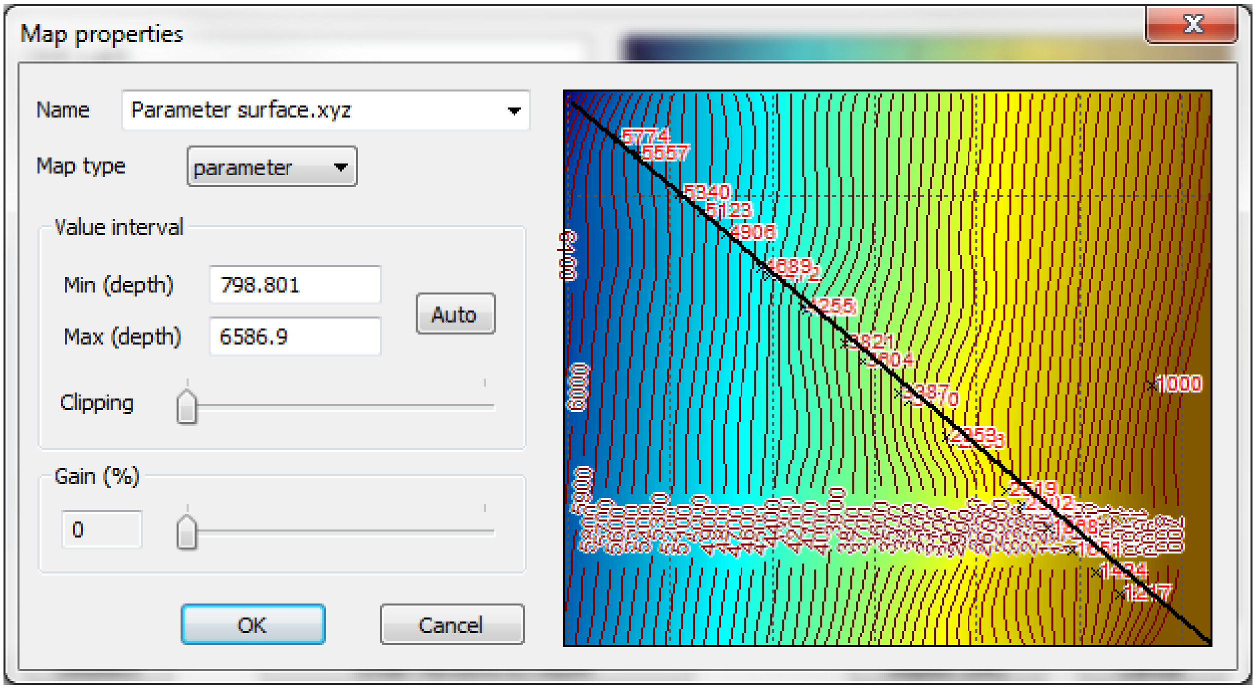
Gain (%): 0

Once `Map type` has been defined, assign the gradient value for both: the upper and lower surface (i.e. to the `Map type: top` and `Map type: bottom`), in the `Map > Manage/ Delete Surfaces > Properties`, which this will produce the vertical gradient.


Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
DWABAM(4)-local.grd
2700
2680
2660
2640
2620
2580
2560
2540
2520
2500
2480
2460
2440
2420
2400
2380
2360
Y
X
2400
2600
2800
3000
3200
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
1
2
3
4
2450
2500
2550
2600
2650
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 242 x 6 mm,
1 frames selected

4.11.2 Introducing horizontal gradients in 3D cubes

A horizontal gradient can only be introduced from surfaces. Such surfaces can be easily created by introducing the X Y V coordinates in a text file (having the .xyz extension). These velocity surfaces are loaded like any other regular surfaces `File> Load Map file` and should be assigned `Map type: Parameter` in the `Map > Manage/ Delete Surfaces > Properties`.



Map properties

Name: Parameter surface.xyz

Map type: parameter

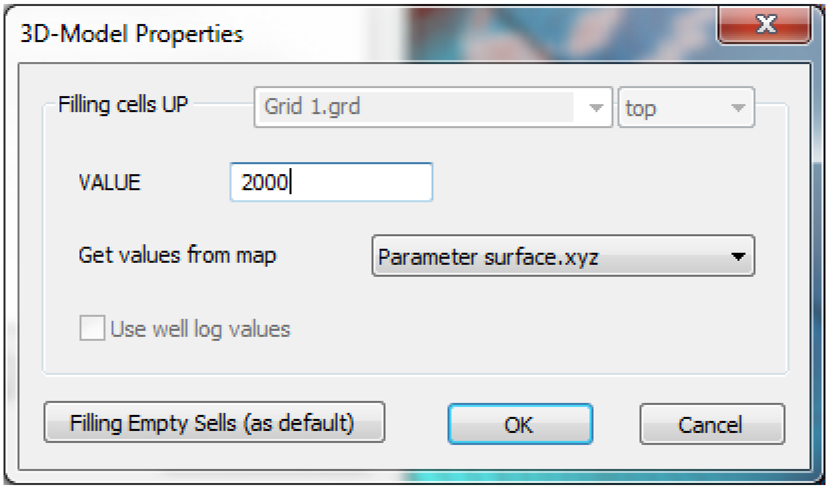
Value interval

Min (depth): 798.801

Max (depth): 6586.9

Gain (%): 0

Afterwards, the horizontal gradient (or the velocity surface) can be assigned to the appropriate surface in the `Map > Manage/ Delete Surfaces > Surface 3D-model Properties>Get value from map`. Please note that a `VALUE` must be introduced as well, in case there are any "holes" in the velocity map in places of faulting, wedging or other complex geologic features. If there are no holes in the velocity map, then the specified `VALUE` will be ignored.



3D-Model Properties
Filling cells UP

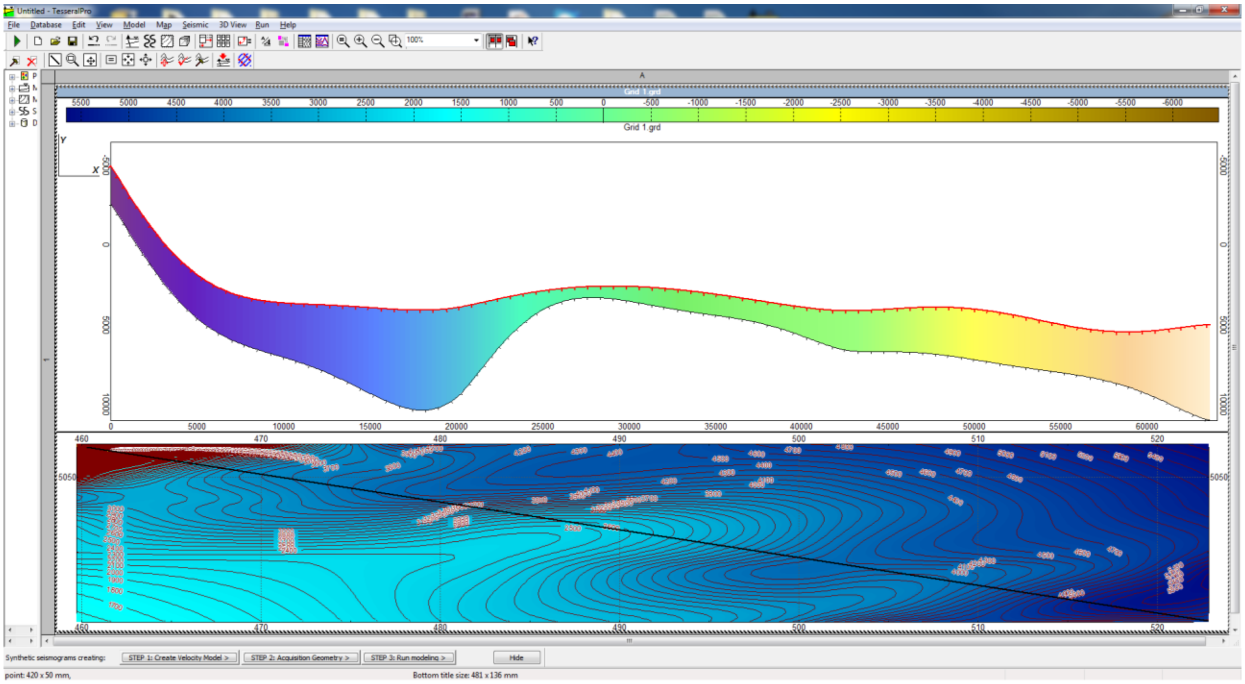
Grid 1.grd top

VALUE 2000

Get values from map: Parameter surface.xyz

☐ Use well log values

Filling Empty Sells (as default)
OK
Cancel

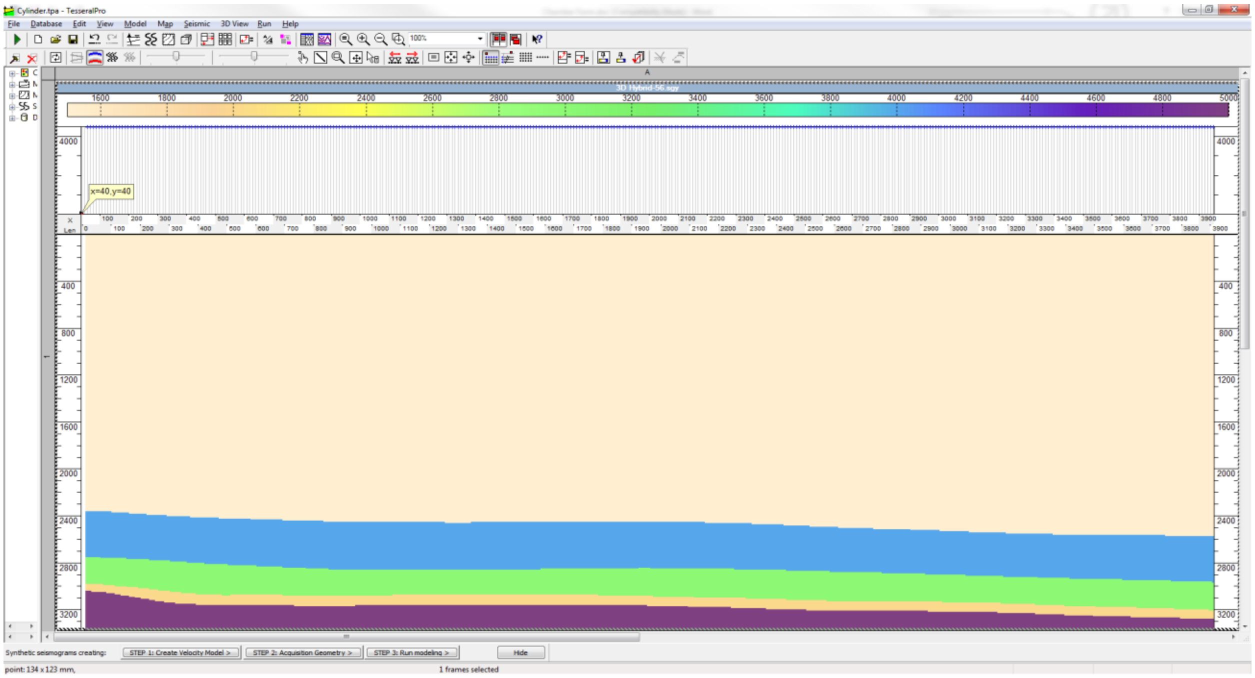


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Grid 1.grd
5500 5000 4500 4000 3500 3000 2500 2000 1500 1000 500 0 -500 -1000 -1500 -2000 -2500 -3000 -3500 -4000 -4500 -5000 -5500 -6000
0 5000 10000 15000 20000 25000 30000 35000 40000 45000 50000 55000 60000
460 470 480 490 500 510 520
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 420 x 50 mm,
Bottom title size: 481 x 136 mm

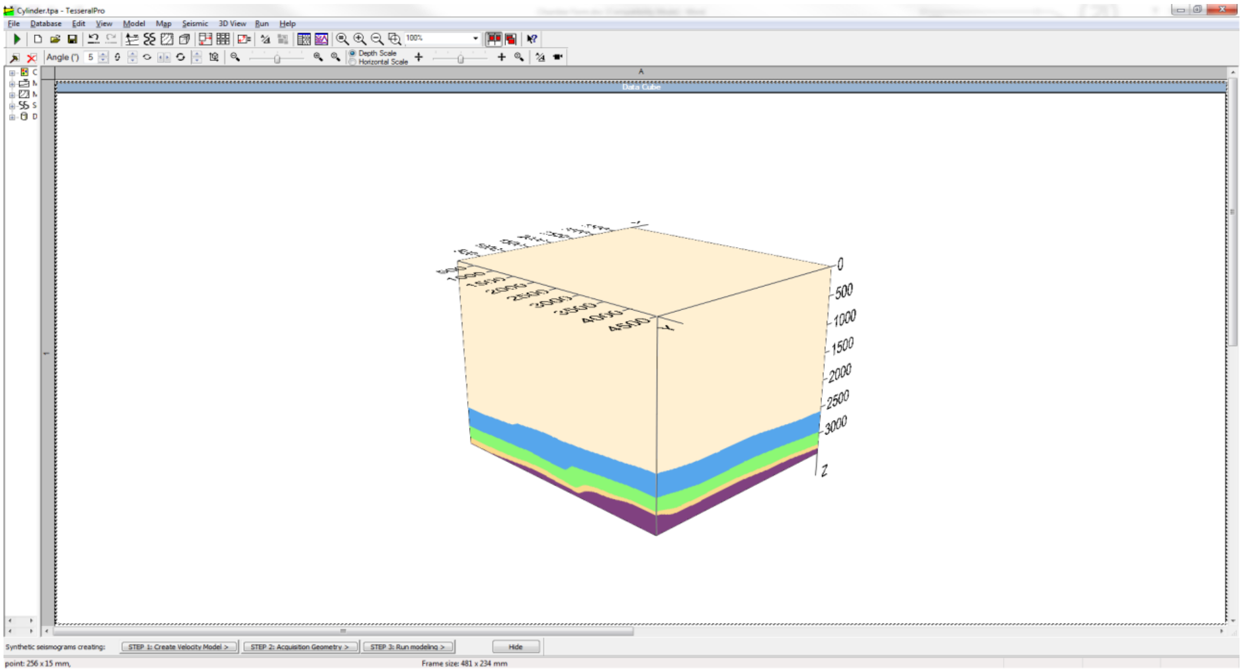
4.11.3 Introducing cylindrical bodies and tetrahedrons in 3D SGY cubes

The user can also introduce cylinders and tetrahedrons in any given 3D SGY cube.

To introduce a cylinder, first of all load the SGY cube in the seismic frame <u>`File> Load Seismic file`</u>

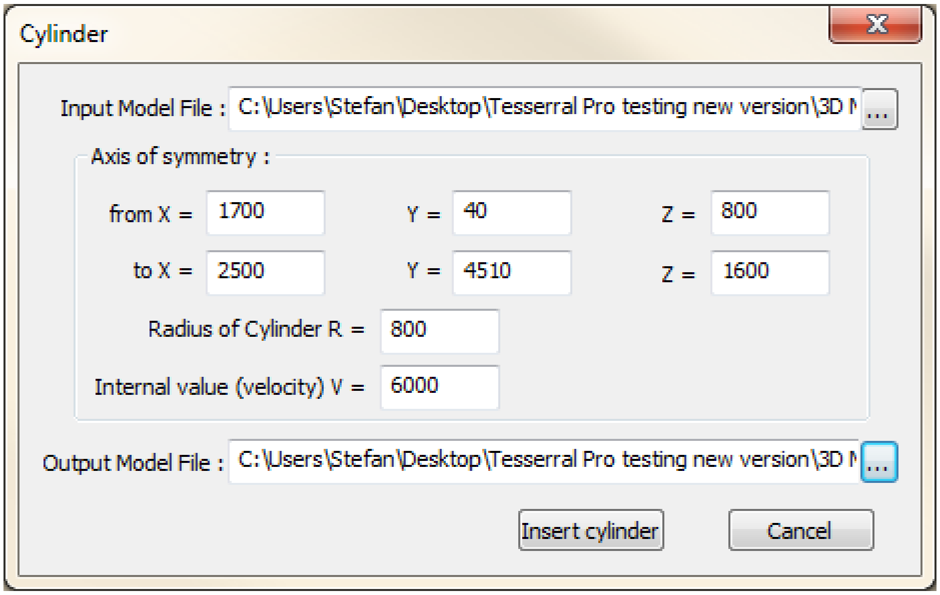

Cylinder.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
x=40,y=40
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 134 x 123 mm,
1 frames selected

The cube in 3D (optional view):


Cylinder.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Data Cube
0
500
1000
1500
2000
2500
3000
Z
Y
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 256 x 15 mm,
Frame size: 481 x 234 mm

Then click <u>`Run> Velocity Model Insert cylinder in Model Cube`</u>

Specify the extension of the cylinder across `X`, `Y` and `Z` axes, as well as its `Radius` and `Internal value`. `Insert cylinder` upon completion.



Cylinder

Input Model File : C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D

Axis of symmetry :

from X = 1700 Y = 40 Z = 800

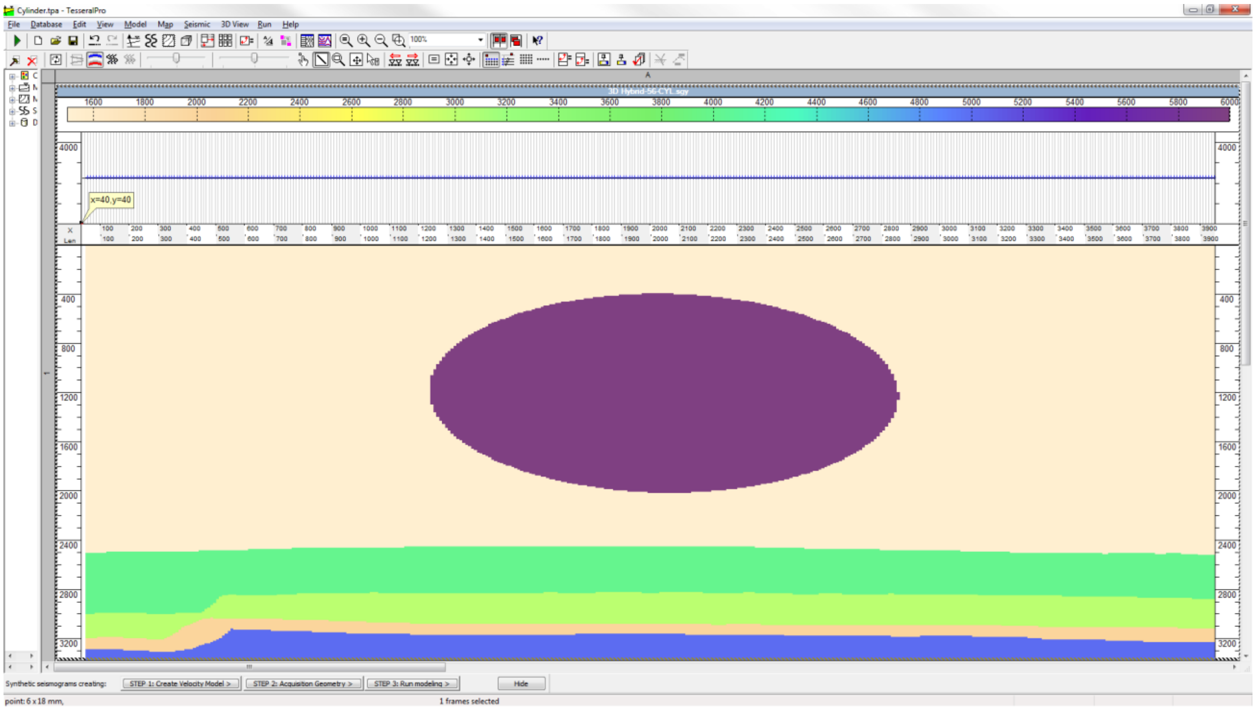
to X = 2500 Y = 4510 Z = 1600

Radius of Cylinder R = 800

Internal value (velocity) V = 6000

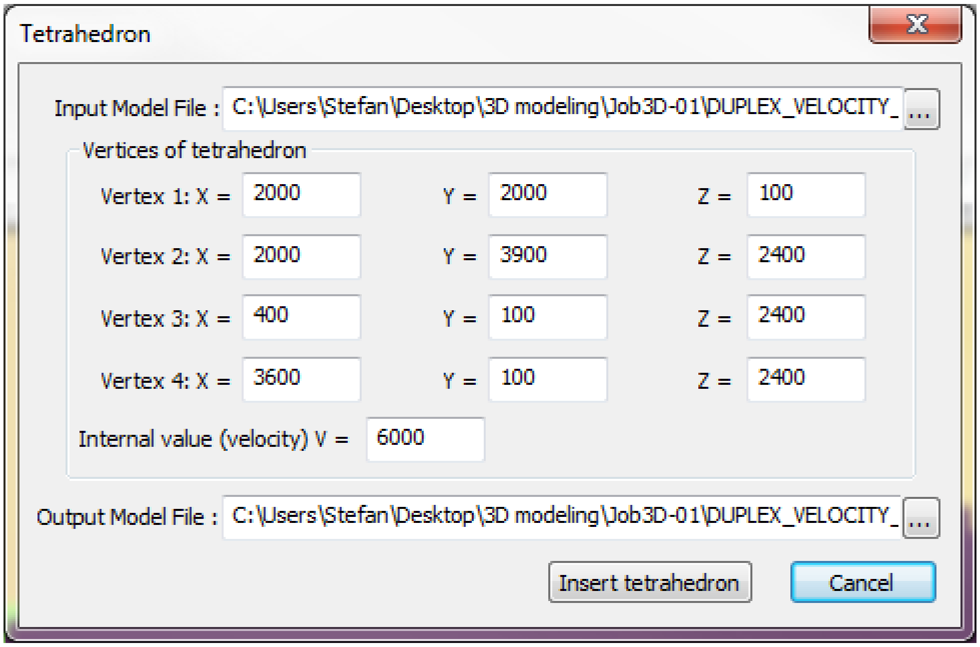
Output Model File : C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D

...
...
Insert cylinder
Cancel



Cylinder.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
x=40,y=40
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
1 frames selected

To introduce a tetrahedron, likewise load the SGY cube in the seismic frame `File> Load Seismic file`, then `Run> Insert Tetrahedron in Model Cube.` Now you will specify the coordinates of the 4 vertices, as well as the `Internal value` of this tetrahedron.



Tetrahedron
X
...
Insert tetrahedron
Cancel

Input Model File : C:\Users\Stefan\Desktop\3D modeling\Job3D-01\DUPLEX_VELOCITY_

Vertices of tetrahedron

Vertex 1: X = 2000 Y = 2000 Z = 100

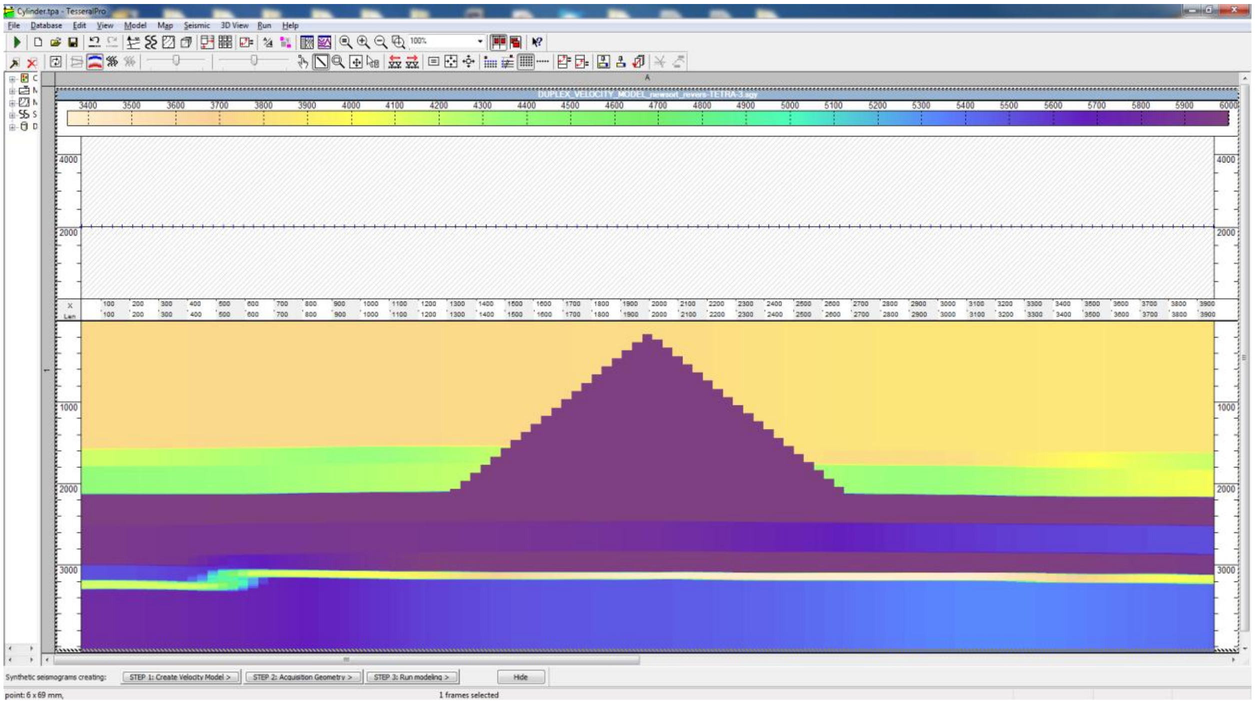
Vertex 2: X = 2000 Y = 3900 Z = 2400

Vertex 3: X = 400 Y = 100 Z = 2400

Vertex 4: X = 3600 Y = 100 Z = 2400

Internal value (velocity) V = 6000

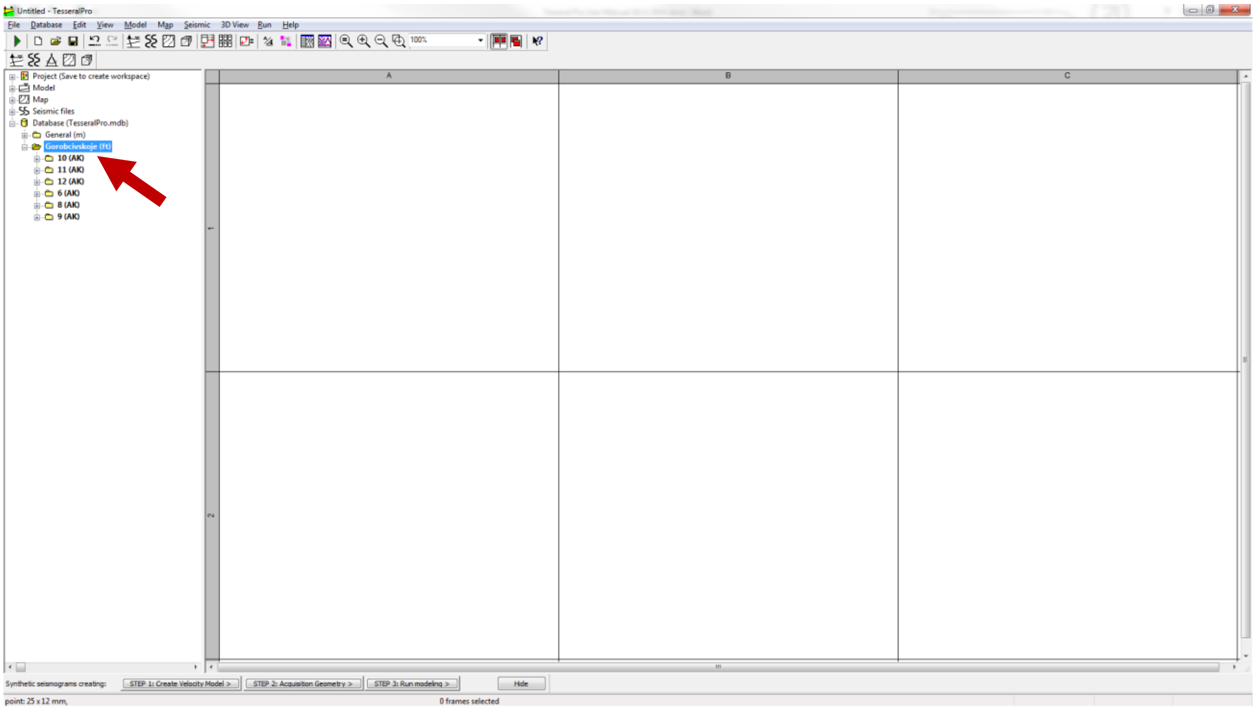
Output Model File : C:\Users\Stefan\Desktop\3D modeling\Job3D-01\DUPLEX_VELOCITY_



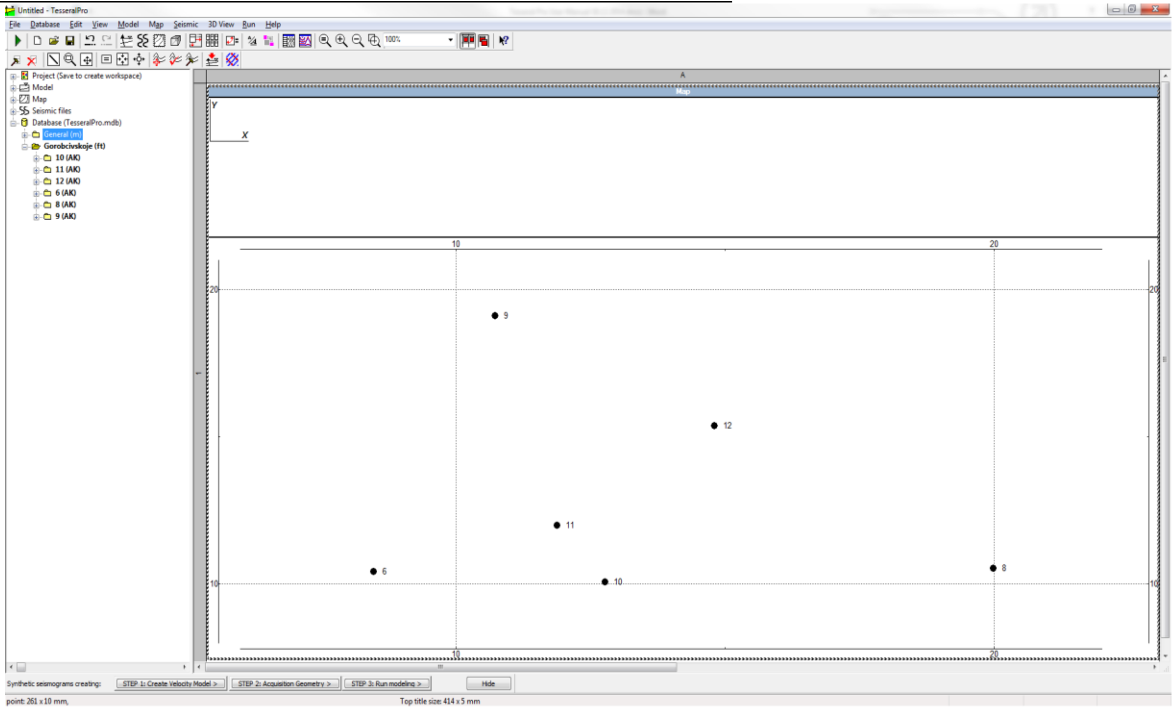
Cylinder.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
DUPLEX_VELOCITY_MODEL_newsort_revers-TETRA-3.sgy
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
5100
5200
5300
5400
5500
5600
5700
5800
5900
6000
4000
2000
1000
2000
3000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 6 x 69 mm,
1 frames selected

4.12 3D model building from well data

In order to build a 3D model from interpolated mapping of well logs, the user first needs to select the desired oil field from the `Database` (in the left window of Tesseral Pro). This is done by right clicking the field name and selecting `Select field for the project.`

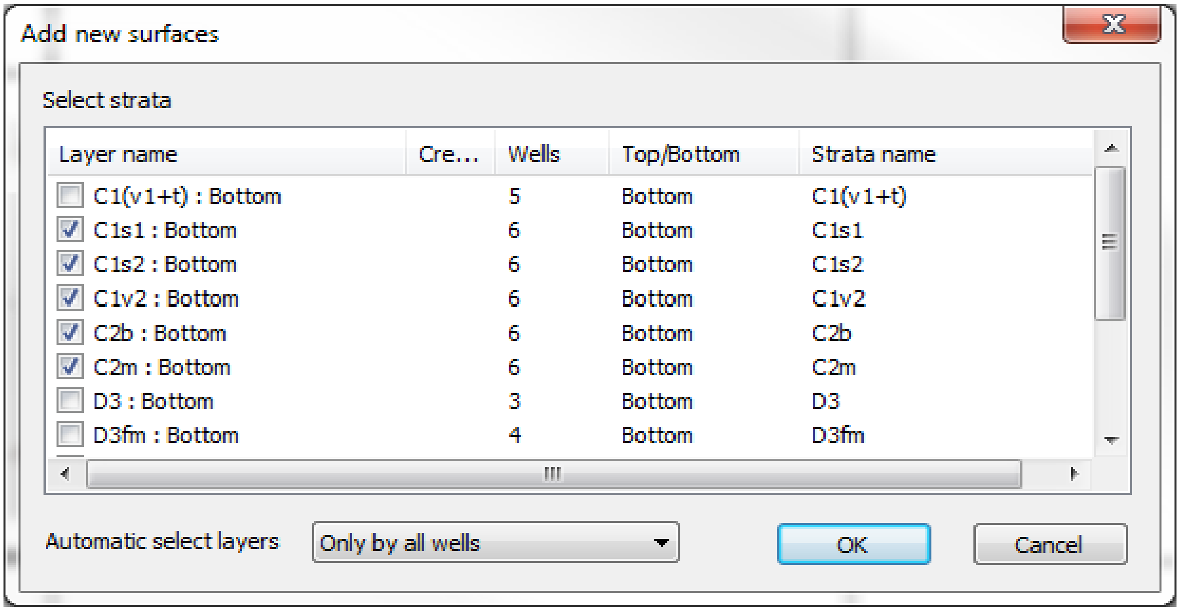

Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Project (Save to create workspace)
Model
Map
Seismic files
Database (TesseralPro.mdb)
General (m)
Gorobcivskoje (ft)
10 (AK)
11 (AK)
12 (AK)
6 (AK)
8 (AK)
9 (AK)
A
B
C
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 25 x 12 mm,
0 frames selected

Afterwards, the user needs to create a map with all the wells by pressing `Map > Create Map (New Frame)>Show database WELLS.`


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Project (Save to create workspace)
Model
Map
Seismic files
Database (TesseralPro.mdb)
General (m)
Gorobcivskoje (ft)
10 (AK)
11 (AK)
12 (AK)
6 (AK)
8 (AK)
9 (AK)
A
Map
Y
X
10
20
9
12
11
6
10
8
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 261 x 10 mm,
Top title size: 414 x 5 mm

The resulting blank map will contain all wells from the chosen oil field.

Next, go `Map > Calculation of horizon from well Tops` and select the stratigraphic layers that need to mapped.

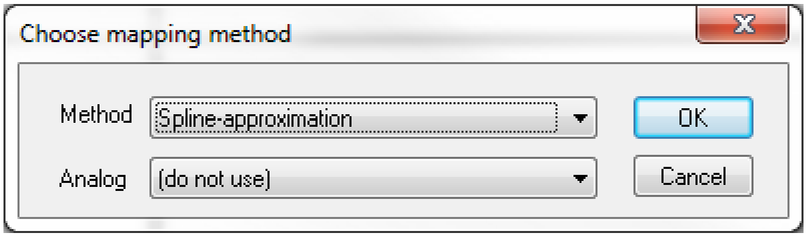


Layer name	Cre...	Wells	Top/Bottom	Strata name
☐ C1(v1+t) : Bottom		5	Bottom	C1(v1+t)
☑ C1s1 : Bottom		6	Bottom	C1s1
☑ C1s2 : Bottom		6	Bottom	C1s2
☑ C1v2 : Bottom		6	Bottom	C1v2
☑ C2b : Bottom		6	Bottom	C2b
☑ C2m : Bottom		6	Bottom	C2m
☐ D3 : Bottom		3	Bottom	D3
☐ D3fm : Bottom		4	Bottom	D3fm

Automatic select layers: Only by all wells

`Automatic select layers` provides various selection criteria for choosing these layers. For example: `Only by all wells` automatically selects only the layers that are common to all wells in the project.

Once the layers have been selected the user will have to specify the interpolation method to be used in the `Choose mapping method` window(see Section ***14.2.4)***

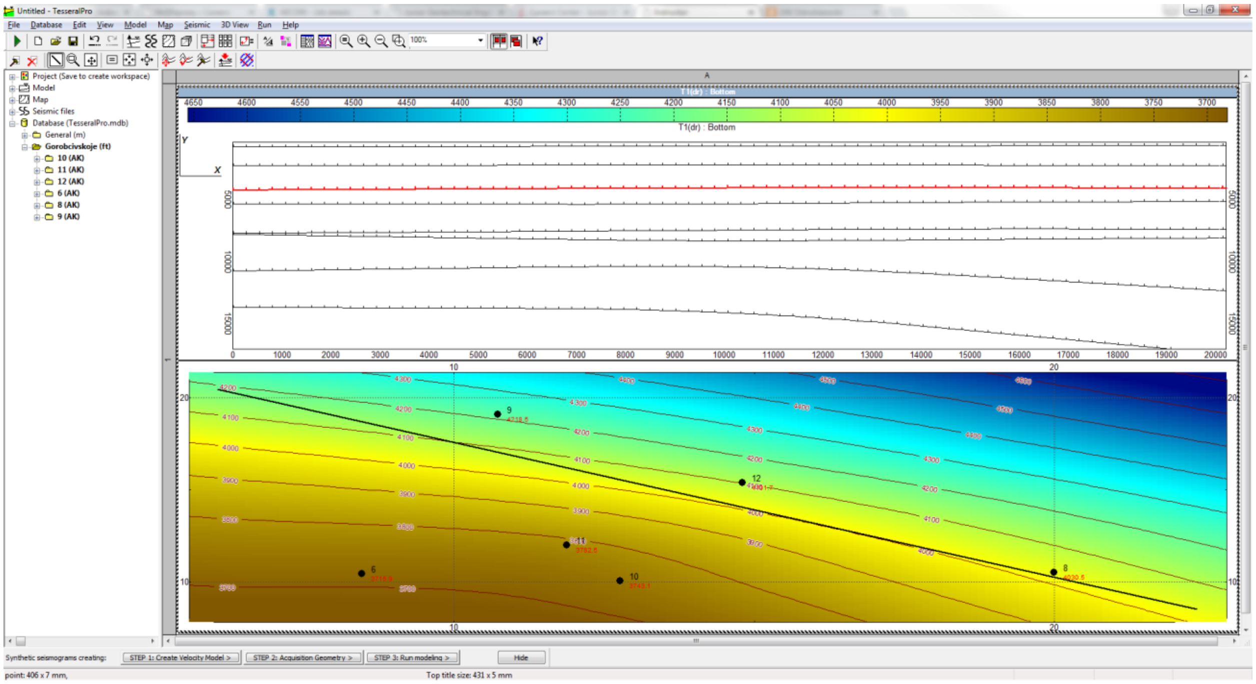


Method: Spline-approximation

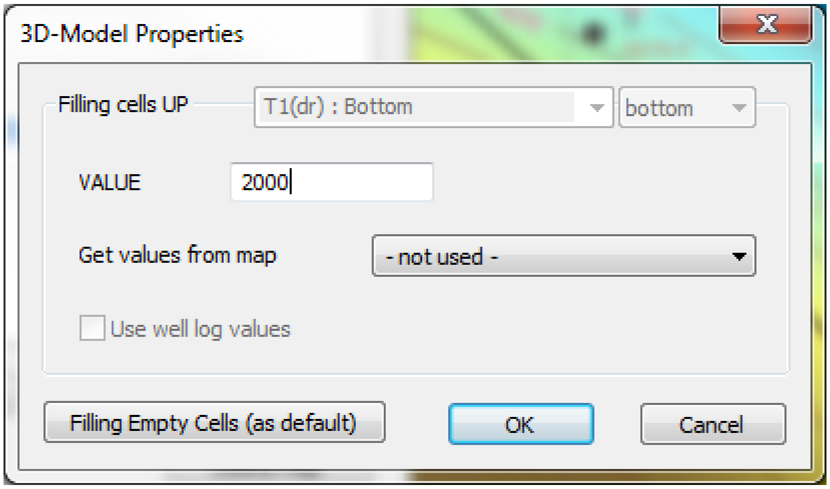
Analog: (do not use)

Beyond this point the generated stratigraphic surfaces can be examined in `Map > Manage/Delete Surfaces`.

From this point on, the user should follow the instructions from Section ***4.11*** (i.e. starting with drawing a cross section across the surfaces first `Map>Section Mode.`


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Project (Save to create workspace)
Model
Map
Seismic files
Database (TesseralPro.mdb)
General (m)
Gorobcivskoje (ft)
10 (AK)
11 (AK)
12 (AK)
6 (AK)
8 (AK)
9 (AK)
T1(dr) : Bottom
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 406 x 7 mm,
Top title size: 431 x 5 mm

Followed by assigning values to the void layers created by the stratigraphic surfaces in the `Map > Manage/ Delete Surfaces > 3D-model Properties`.


3D-Model Properties

Filling cells UP: T1(dr) : Bottom — bottom

VALUE: 2000

Get values from map: - not used -

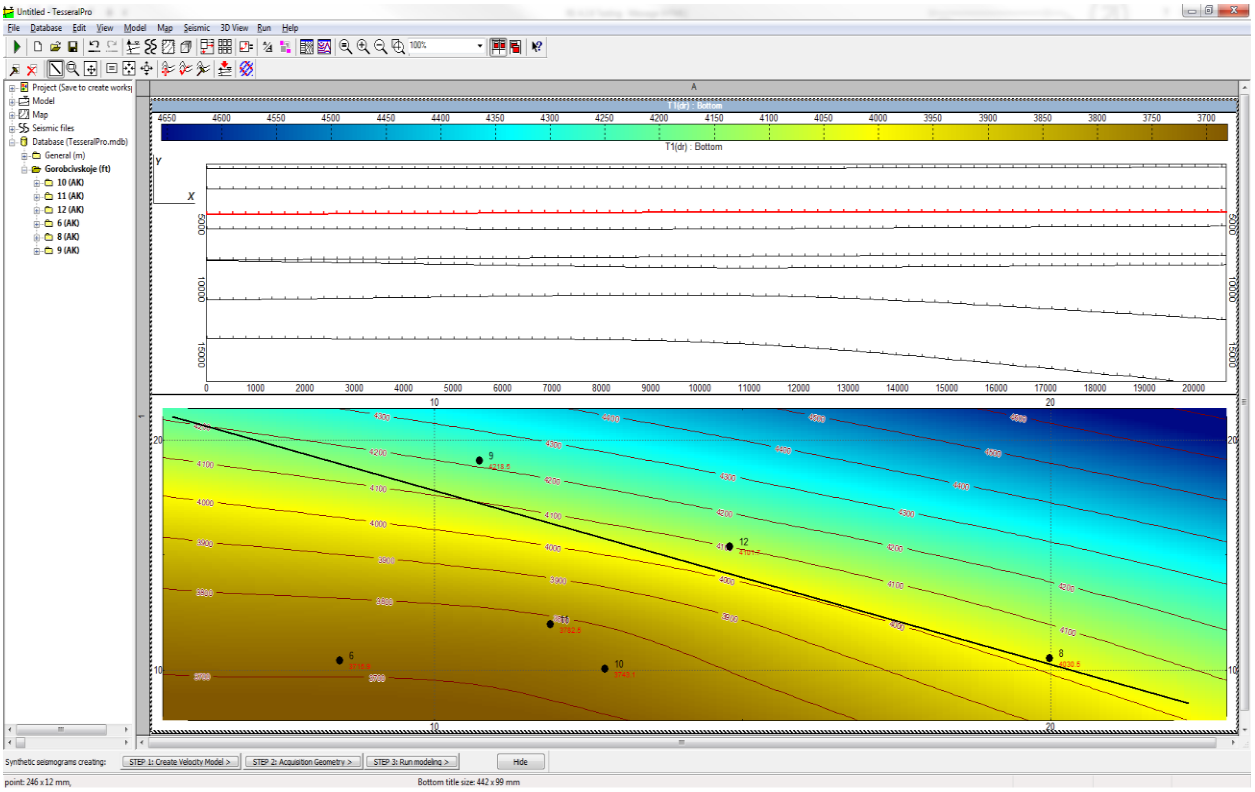
☐ Use well log values

Filling Empty Cells (as default)
OK
Cancel

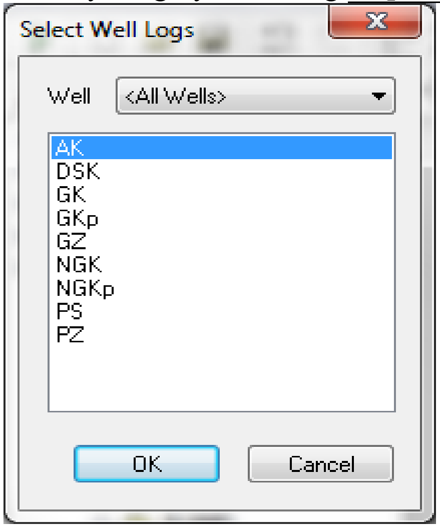
4.12.1 Building a thin layered 3D model

In order to build a 3D thin layered model from well data, the user will first need to create surfaces from the stratigraphic data in the `Database` wells and this procedure was explained in Section ***4.12***

For instructions on how to import log data, as well as stratigraphic and inclinometry data, please follow the instructions from Section ***17.5***


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Project (Save to create works)
Model
Map
Seismic files
Database (TesseralPro.mdb)
General (m)
Gorobcivskoje (ft)
10 (AK)
11 (AK)
12 (AK)
6 (AK)
8 (AK)
9 (AK)
T1(dr) : Bottom
4650 4600 4550 4500 4450 4400 4350 4300 4250 4200 4150 4100 4050 4000 3950 3900 3850 3800 3750 3700
Y
X
5000
10000
15000
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000
10
20
9
12
11
6
10
8
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 246 x 12 mm,
Bottom title size: 442 x 99 mm

Once all surfaces have been generated, the user will have to choose the well log data used for thin-layering by accessing `Map>Load Well Logs`

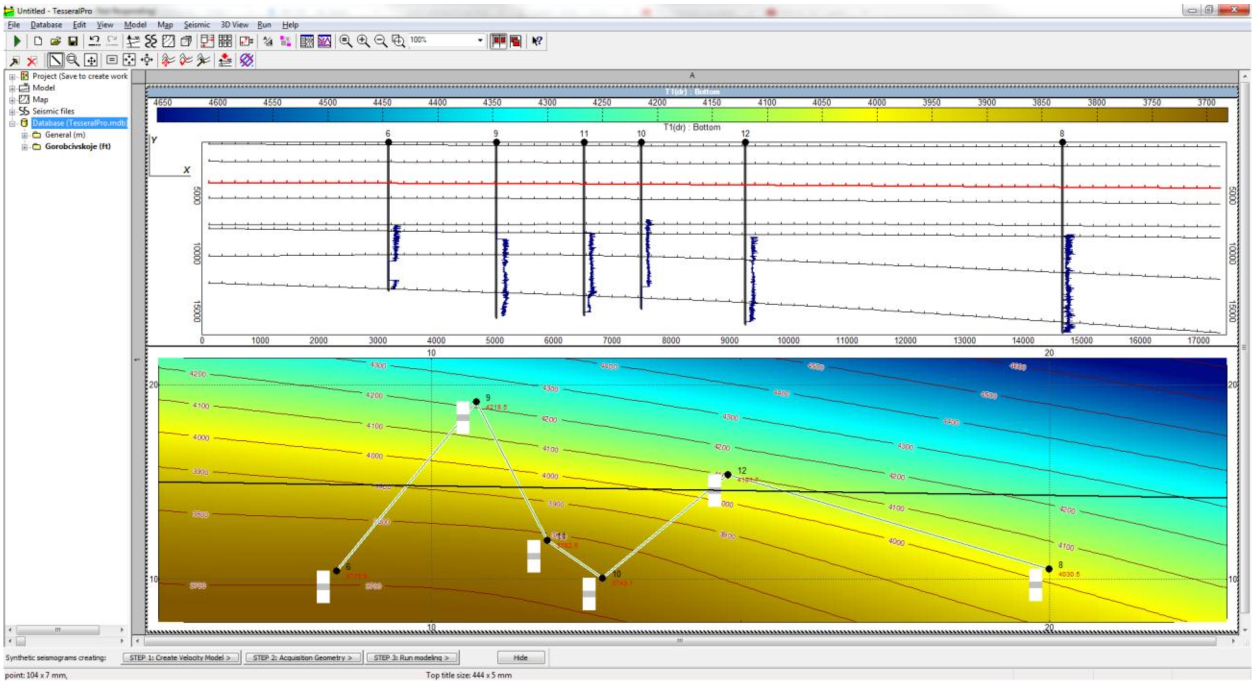

Select Well Logs
AK
DSK
GK
GKp
GZ
NGK
NGKp
PS
PZ
OK
Cancel

Well <All Wells>

If you have not drawn a profile over your map frame already, please do so by going `Map>Section Mode` and draw the profile using the left mouse button.

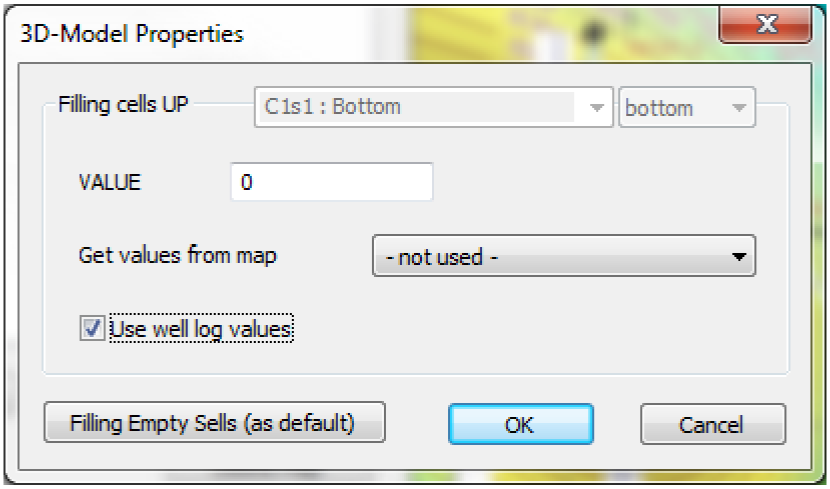
Once the log data has been selected, the user will have to select the wells, which are to be used for 3D thin layered model building. In order to select a well, right click on it in the map frame and select `Add well to profile`. Repeat this for all desired wells.

Now, all your logs should appear in the cross section of the map frame:



Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Project (Save to create work
Model
Map
Seismic files
Database (TesseralPro.mdb)
General (m)
Gorobcivskoje (ft)
T1(dr) : Bottom
6
9
11
10
12
8
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

The thin layering for the surfaces covered by the log data is assigned, as previously, in the `Map > Manage/ Delete Surfaces > Surface 3D-model Properties` tab by checking `Use well log Values`.


3D-Model Properties
Filling cells UP
Filling Empty Sells (as default)
OK
Cancel

C1s1 : Bottom

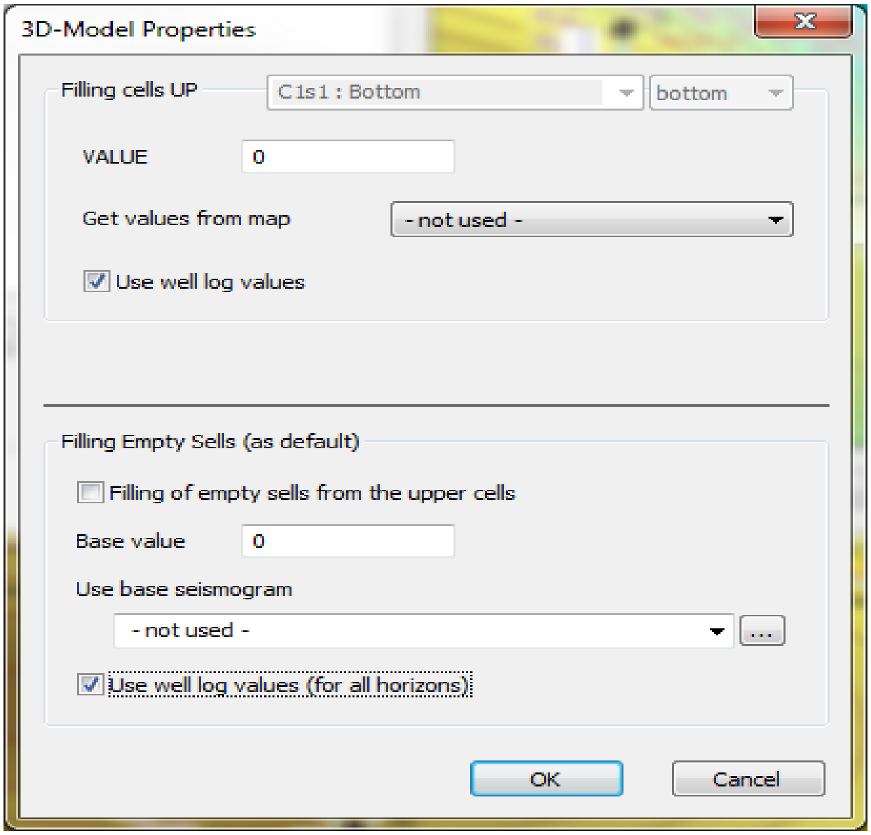
bottom

VALUE 0

Get values from map - not used -

☑ Use well log values

If you would like to fill in the all the surfaces from log data checkmark `Map > Manage/ Delete Surfaces > Surface 3D-model Properties> Filling Empty Cells(as default)>Use well log values(for all horizons)`.


3D-Model Properties
Filling cells UP
Filling Empty Sells (as default)
...
OK
Cancel

C1s1 : Bottom

bottom

VALUE 0

Get values from map - not used -

☑ Use well log values

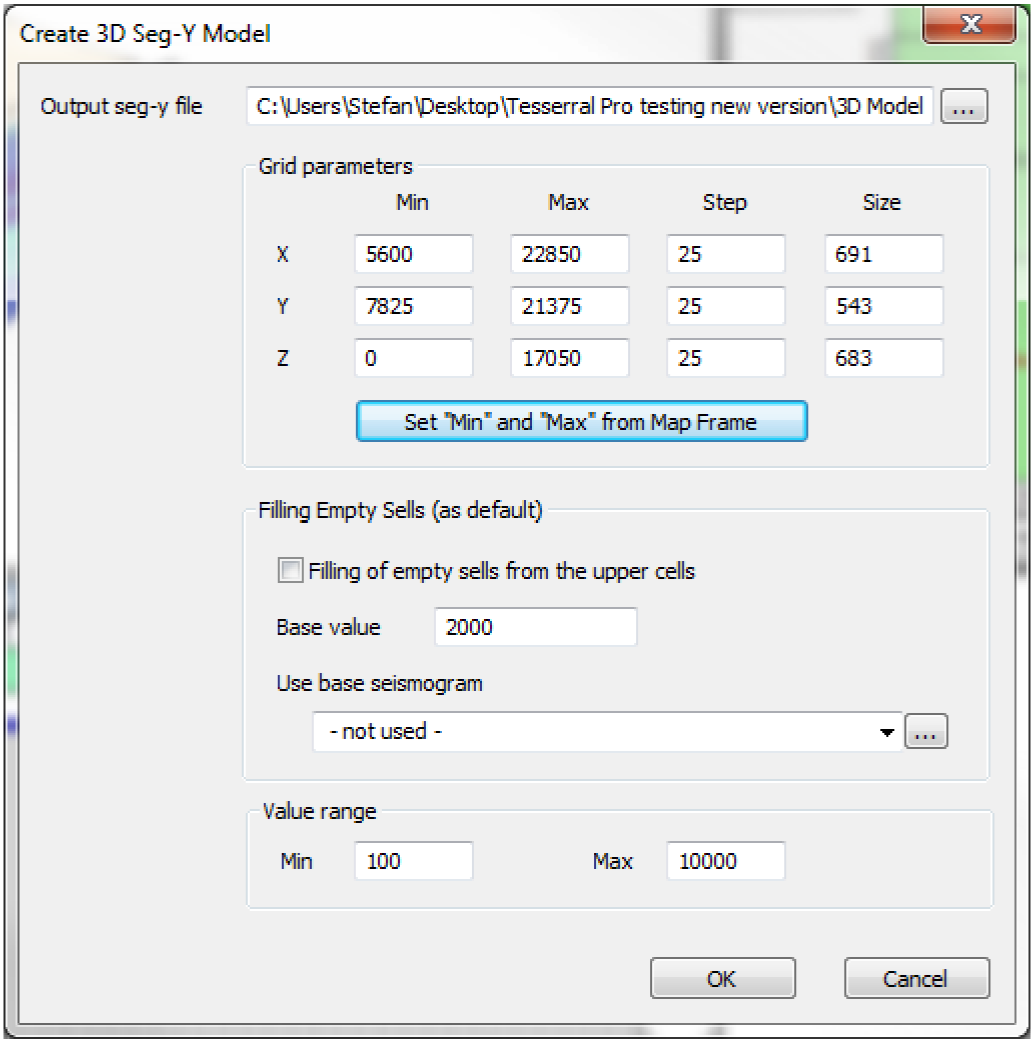
☐ Filling of empty sells from the upper cells

Base value 0

Use base seismogram - not used -

☑ Use well log values (for all horizons)

Once all surfaces have been filled select `Run > Map Frame > Create 3D SEG-Y`



Output seg-y file: C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D Model

Grid parameters

	Min	Max	Step	Size
X	5600	22850	25	691
Y	7825	21375	25	543
Z	0	17050	25	683

Filling Empty Sells (as default)

☐ Filling of empty sells from the upper cells

Base value: 2000

Use base seismogram: - not used -

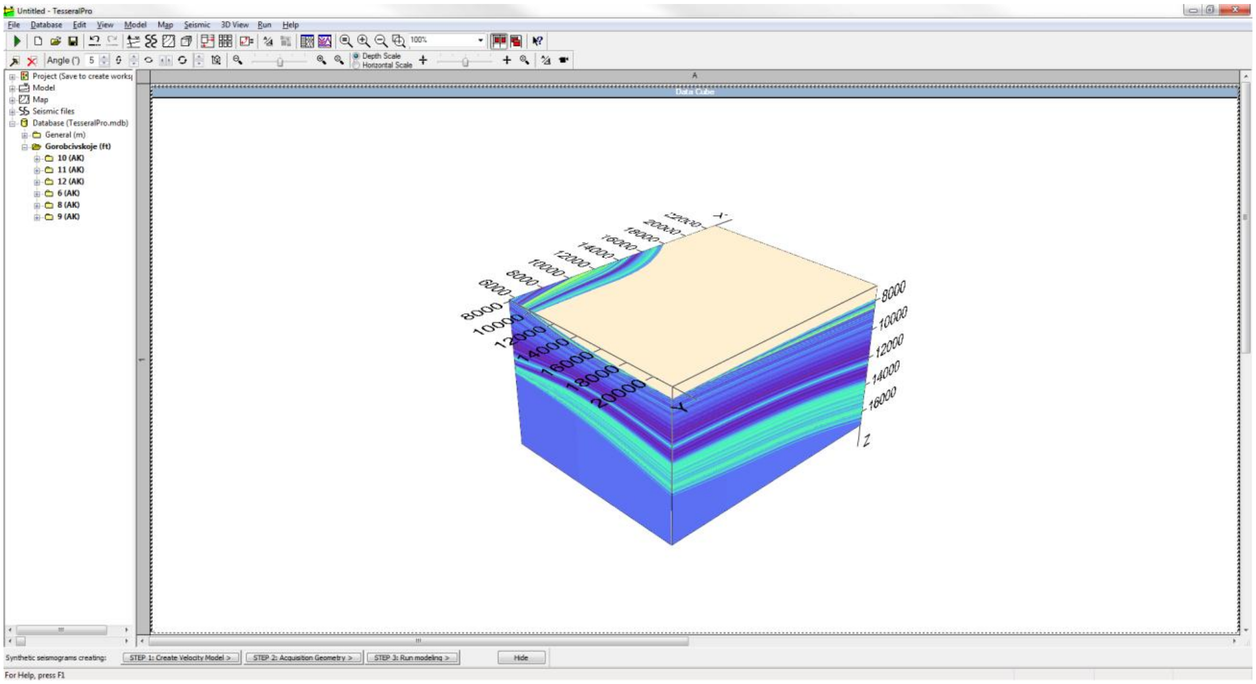
Value range

Min: 100
Max: 10000

Specify the X, Y, Z dimensions you want for your 3D model, the grid sampling, as well as the `Filling cells` value with which you want to fill the remaining blank layer(s).
If you want to fill the remaining blank layer(s) from a base seismogram (i.e. from 3D SGY cube), then load it in the `Use base seismogram`.

Here, you can also introduce limitations to the min. and max. values for the thin layering in the `Value Range`.

Finally, after clicking `OK` a thin layered cube from log data will be generated.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Angle (°) 5
Depth Scale
Horizontal Scale
Project (Save to create works
Model
Map
Seismic files
Database (TesseralPro.mdb)
General (m)
Gorobcivskoje (ft)
10 (AK)
11 (AK)
12 (AK)
6 (AK)
8 (AK)
9 (AK)
A
Data Cube
X
22000
20000
18000
16000
14000
12000
10000
8000
6000
8000
10000
12000
14000
16000
18000
20000
Y
8000
10000
12000
14000
16000
Z
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

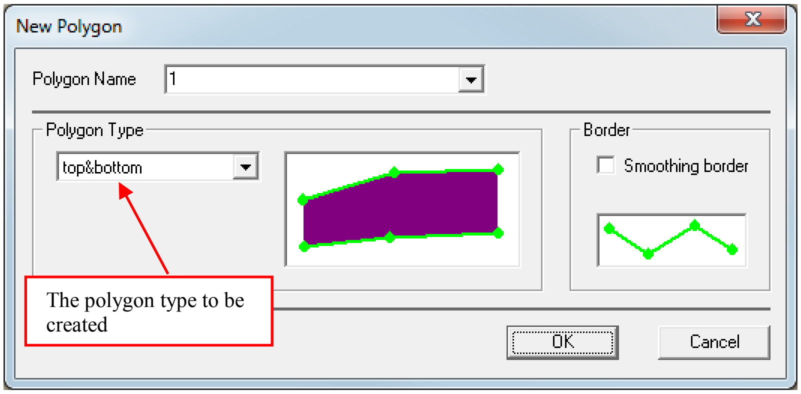
5 Polygon creation and editing

After an empty model (Model Frame) is created, it has to be filled with geological objects of various rock physical properties. In the Tesseral Pro, polygons are used to represent geological objects. In model building, a polygon is characterized by a set of parameters, such as compressional- and shear-wave velocity, density, anisotropic parameters and fracturing. In such manner, any area of the model can be filled with polygons with determined properties.

During the setup of the modeling job (synthetic gathers calculation), a grid with the given step along the section direction and depth direction is created from the polygonal model. The parameters for each node of this grid are obtained from the polygon in which the node is located. If the location of a node is overlapped by several polygons, then its parameters are obtained from the upper-most polygon.

5.1 Create a polygon manually

Please select the menu `Model` using the mouse, and then select the command `New Polygon`.



New Polygon

Polygon Name: 1

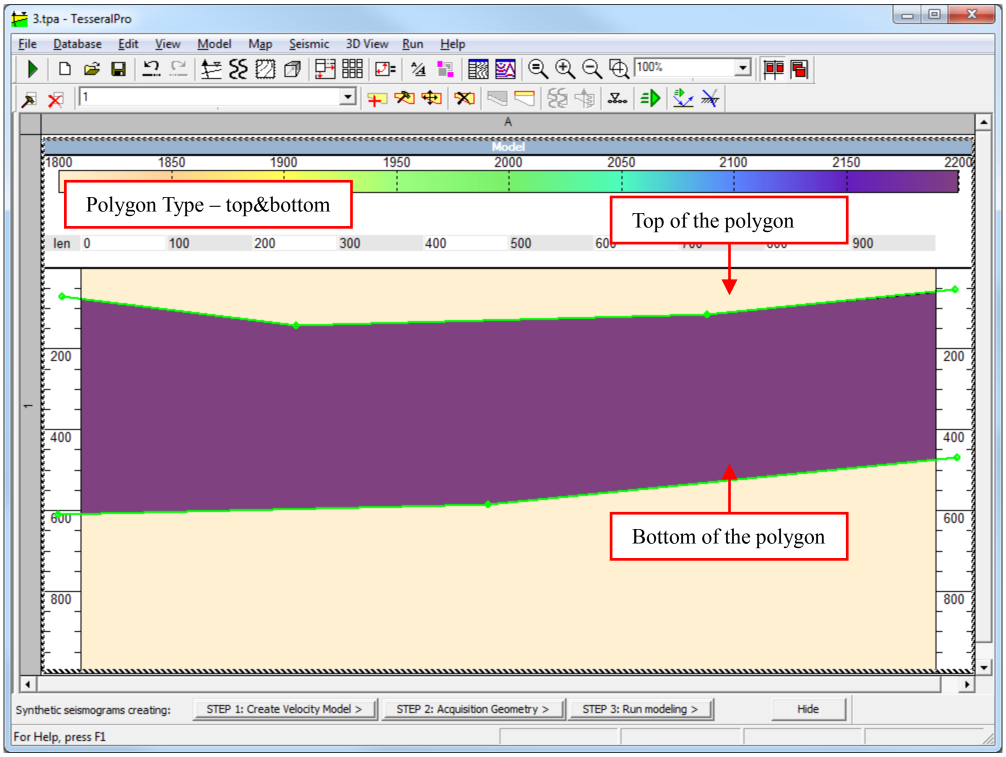
Polygon Type: top&bottom

Border: ☐ Smoothing border

The polygon type to be created

In the dialogue box `New Polygon`, please select or specify the polygon name (`Polygon Name`), and select the type of polygon to be created (`Polygon Type`). The following polygon types are supported:

- `Polygon Type`: `top&bottom` – the user needs to draw the top and bottom of the polygon. The right and left sides will match to the corresponding boundaries of background model (base polygon).



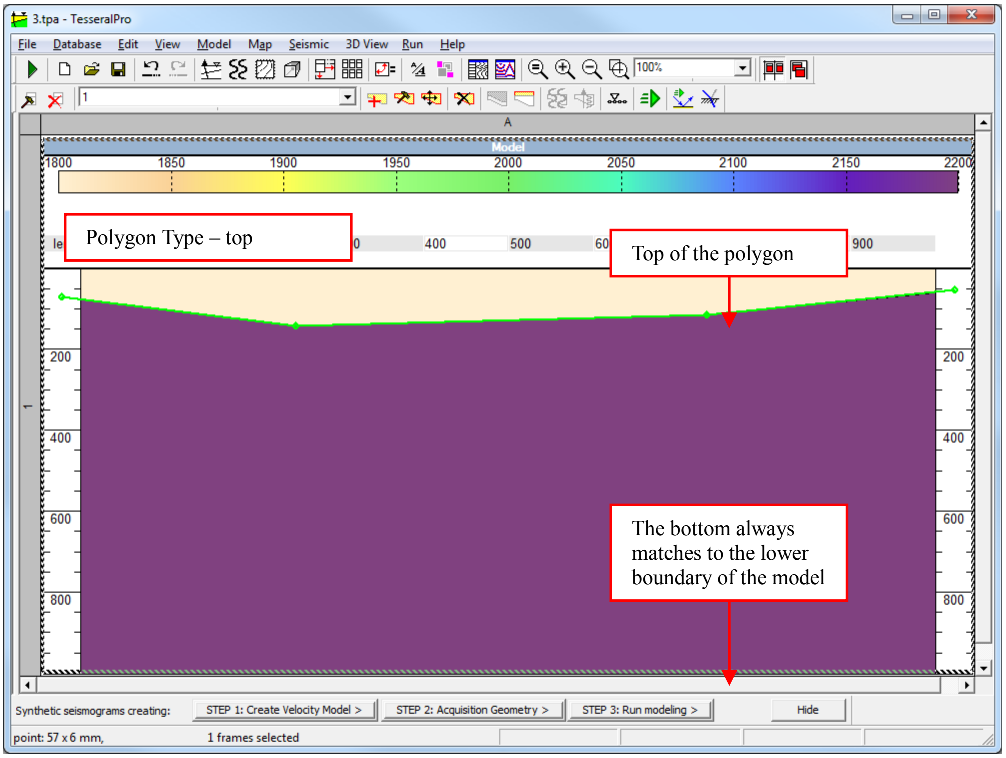
3.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
1
A
Model
1800
1850
1900
1950
2000
2050
2100
2150
2200
len
0
100
200
300
400
500
600
900
200
400
600
800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

Polygon Type – top&bottom

Top of the polygon

Bottom of the polygon

- `Polygon Type`: `top` – the user needs to draw only the top of the polygon. And then the other 3 boundaries will match the corresponding boundaries of background model (base polygon) automatically.

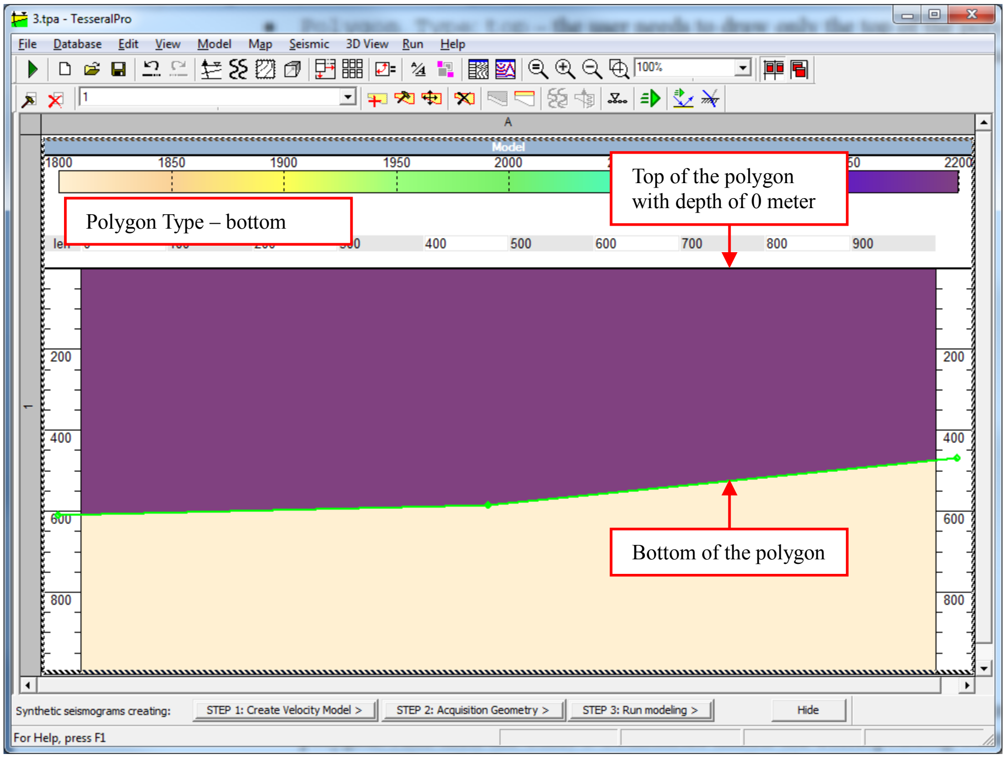

3.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
1
A
Model
1800 1850 1900 1950 2000 2050 2100 2150 2200
400 500 900
200 400 600 800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 57 x 6 mm,
1 frames selected

Polygon Type – top

Top of the polygon

The bottom always matches to the lower boundary of the model

- `Polygon Type`: `bottom` – the user needs to draw only the bottom of the polygon. And then the other 3 boundaries will match the corresponding boundaries of background model (base polygon) automatically. Please note, if the top of the background model is located above the zero depth, the top of polygon will be set to the level of zero-depth.

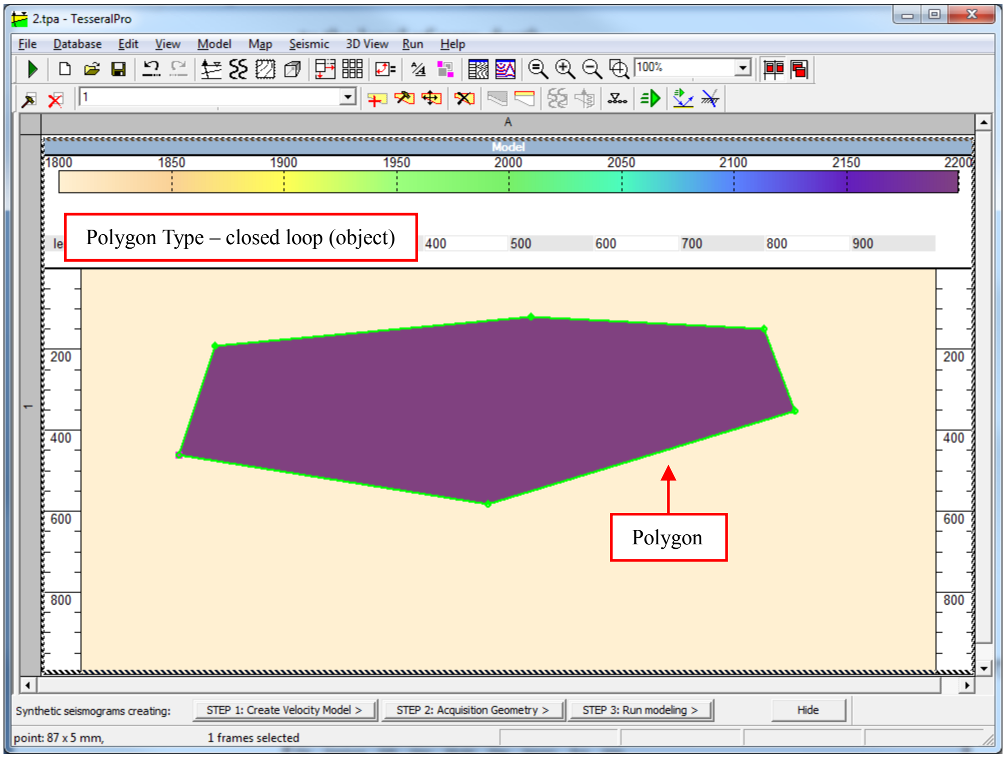

3.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
1
A
Model
1800 1850 1900 1950 2000 2200
400 500 600 700 800 900
200 400 600 800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

Top of the polygon with depth of 0 meter

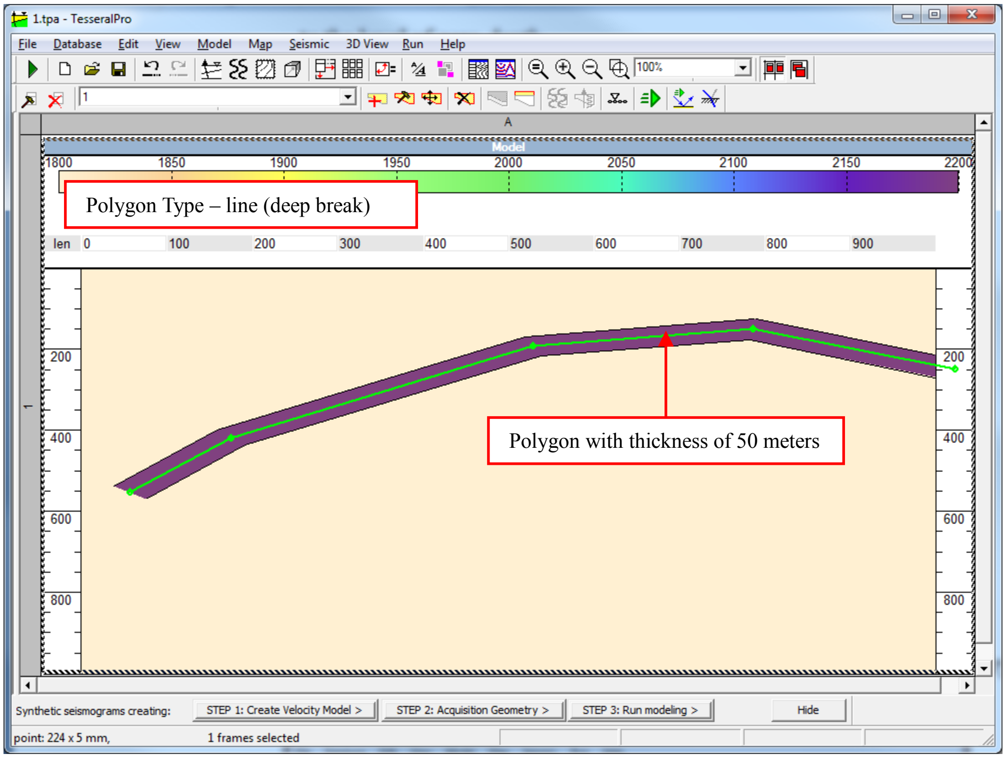
Polygon Type – bottom

Bottom of the polygon

- `Polygon Type`: `closed loop (object)` – a closed boundary need to be drawn.


2.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Model
1800
1850
1900
1950
2000
2050
2100
2150
2200
Polygon Type – closed loop (object)
400
500
600
700
800
900
200
400
600
800
Polygon
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 87 x 5 mm,
1 frames selected

- `Polygon Type`: `line (deep break)` – only a line is drawn, its thickness can be specified by the parameter `width of line (m or ft)` in the dialogue box `New Polygon` when this type of polygon is selected.


1.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Model
1800
1850
1900
1950
2000
2050
2100
2150
2200
Polygon Type – line (deep break)
len 0
100
200
300
400
500
600
700
800
900
200
400
600
800
Polygon with thickness of 50 meters
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 224 x 5 mm,
1 frames selected

Once the polygon has been created please right-click the mouse or double click the left mouse button (must be done within the `Model Frame`). Then, a new extended dialogue box will appear for users to edit the polygon's properties. After exiting from the dialogue box `Polygon Properties`, users can add more nodes to the boundaries of the created polygon by clicking the mouse on its boundary.

5.2 Change polygon’s shape

Users can select a polygon either using the mouse or from the list of all polygons in the toolbar. The boundaries of the selected polygon are shown in green color. If you want to add a node to a polygon boundary, press the left mouse button on the boundary of the polygon. If you want to remove an existing node, click it with the right mouse button. If you want to move a node, press-drag-release it with the left mouse button.

5.3 Move/copy a polygon

Select a polygon using the mouse by left-clicking on it or from the list in the toolbar, and then choose `Model > Drag polygon` menu to move the selected polygon or `Model > Copy Polygon` to copy it. After that, click the left mouse button inside the Model Frame to finish moving or copying.

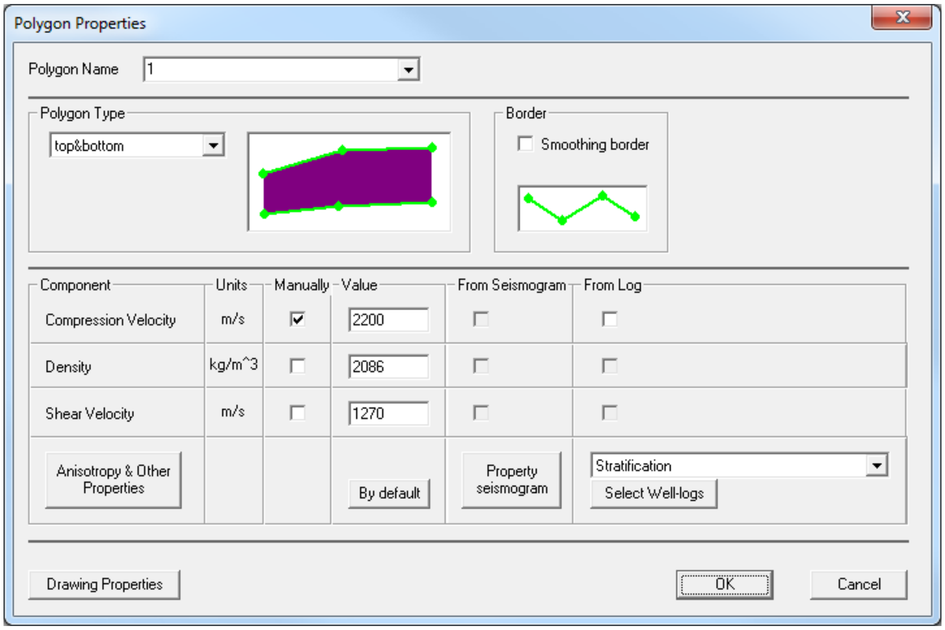
5.4 Delete a polygon

Please use the menu command `Model > Delete polygon` to delete the selected polygon.

NOTE: To undo the previous action, please use the `Undo` command.

5.5 Edit polygon's properties

Please select a polygon with the mouse or from the list of polygons in the toolbar. The boundary of the selected polygon will be highlighted with a bold green line. Then, use the menu command `Model > Edit polygon` to edit the polygon's properties.



Polygon Name: 1

Polygon Type: top&bottom

Border: ☐ Smoothing border

Component	Units	Manually	Value	From Seismogram	From Log
Compression Velocity	m/s	☑	2200	☐	☐
Density	kg/m^3	☐	2086	☐	☐
Shear Velocity	m/s	☐	1270	☐	☐

Stratification

`Polygon Name` is the actual name of the polygon. If a polygon reflects a layer in the well, it is recommended give it the name of that layer. In the `Polygon Name` drop-down list, the complete list of layers' names from the database is shown.

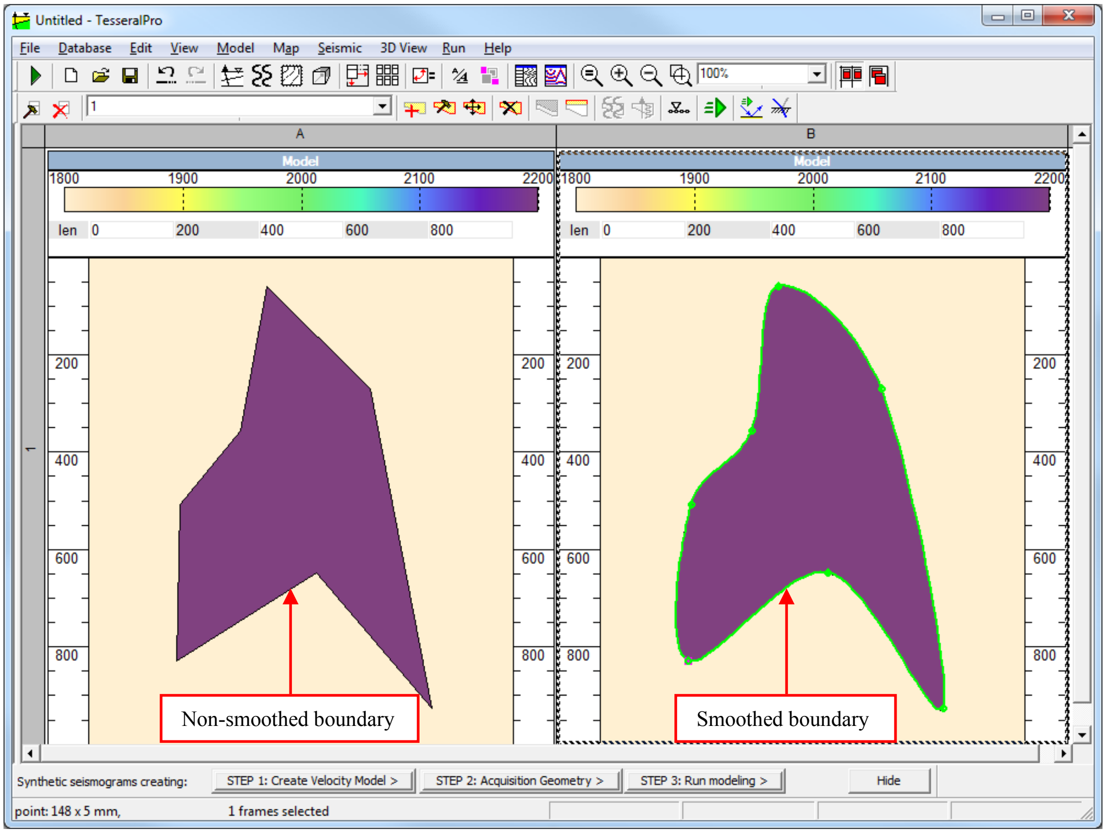
The group `Component` is for editing the velocity, density and other parameters for the polygon. If the `Manually` checkbox is not checked, the corresponding values will be calculated automatically from the other parameters using empirical formulae.

`From Log` – if checked, the polygon's properties will be obtained by interpolating the logging data. The `Select Well-logs` button is for selecting the curves in the `Model Frame` and specifying their type (velocity or density) and measurement units.

`From Seismogram` – if checked, the polygon's properties will be obtained from the data of the underlying seismic file. The `Property seismogram` button is for selecting the underlying seismic file in the `Model Frame` and specifying their type (velocity or density) and measurement units.

The `By default` button is for saving the user-specified values as the default values for future use when a new polygon with the same name is created.

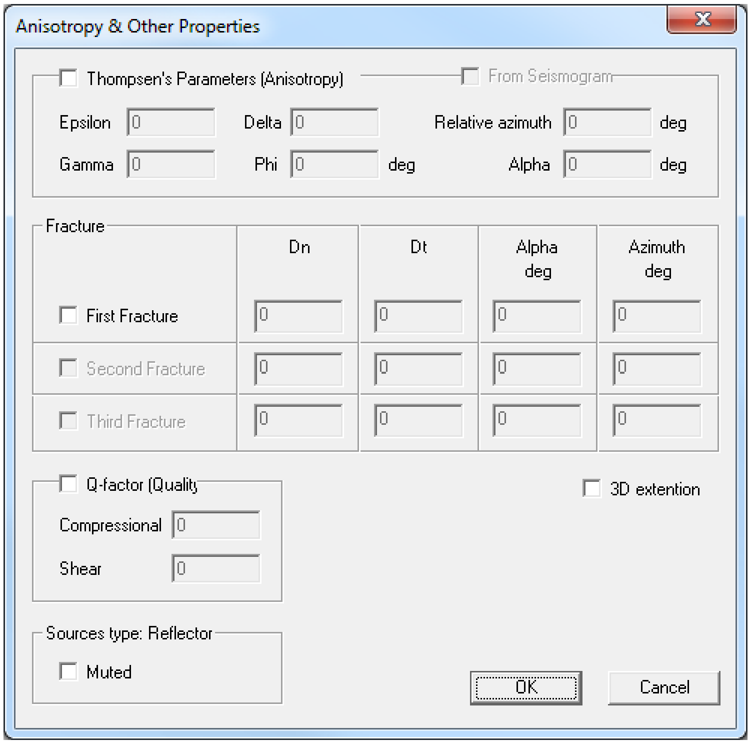
The `Smoothing border` checkbox is for smoothing the polygon's boundaries automatically. In case when the `Polygon Type` is `top&bottom`, the top and the bottom boundaries will be smoothed independently.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
A
B
Model
1800 1900 2000 2100 2200
len 0 200 400 600 800
200
400
600
800
Non-smoothed boundary
Smoothed boundary
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 148 x 5 mm,
1 frames selected

The `Drawing Properties` button is for setting the color filling of the polygon and the attributes of its boundaries. It is only for the visualization, not affecting the calculation of synthetic gathers.

5.6 Anisotropic/fracture/absorption parameters

To specify the anisotropy and/or fracturing parameters, press the `Anisotropy & Other Properties` button. Then, in the dialogue box `Anisotropy & Other Properties`, specify the value for each parameter shown in the pop-up dialogue box (shown below).



Anisotropy & Other Properties

☐ Thompsen's Parameters (Anisotropy)
☐ From Seismogram

Epsilon 0
Delta 0
Relative azimuth 0 deg
Gamma 0
Phi 0 deg
Alpha 0 deg

Fracture

	Dn	Dt	Alpha deg	Azimuth deg
☐ First Fracture	0	0	0	0
☐ Second Fracture	0	0	0	0
☐ Third Fracture	0	0	0	0

☐ Q-factor (Quality
Compressional 0
Shear 0

☐ 3D extention

Sources type: Reflector
☐ Muted

By default, each polygon is isotropic.

Thompsen's Parameters: ε (Epsilon), δ (Delta), γ (Gamma) and the inclination angle φ (Phi) of the symmetry axis of the transversal-isotropic (TI) background medium can be specified. The coefficients ε and δ determine the relative difference of the qP and qSV wave velocity in different propagation directions with respect to velocity along the symmetry axis of the background medium, and they are used only in the Elastic Anisotropy mode. The parameter γ determines the velocity variation of the qSH waves along different propagation direction, and it does not affect wavefield of a 2D modeling (it is added to make the description more complete and for future upgrade).

Fracture describes intensity of fracturing in the background medium, and is characterized by parameters δ_n (Dn), δ_t (Dt) and the fracturing inclination angle α (Alpha) with respect to the vertical direction. Each layer may have 0-3 different fracturing systems. The parameters δ_n (Dn), δ_t (Dt) should be within the limit of [0,…,1]. The inclination angle α (Alpha) is within the limit of [-90°,…,90°]. The parameters δ_n (Dn), δ_t (Dt) depend on the density of fractures, Poisson coefficient of the background medium and the type of materials filling in the fractures. These parameters affect both propagation velocities of all types of waves along different directions, as well as their dynamic properties (amplitude).

Q-factor is for specifying the parameters about the seismic energy absorption in visco-elastic medium. This parameter measures the attenuation of the wave amplitude for a wavelength. The Quality of Compressional and Shear waves can be specified separately.

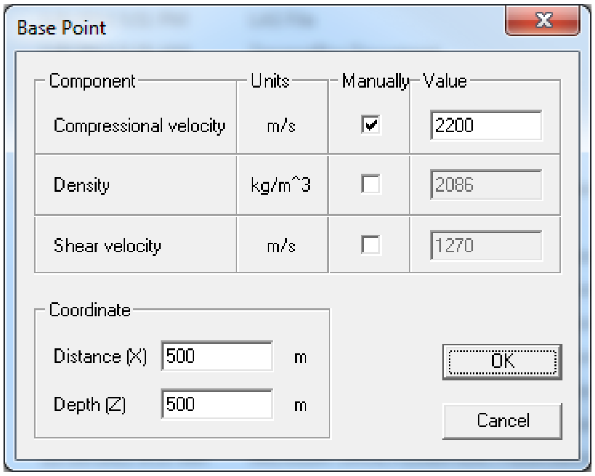
Sources type: Reflector, the option Muted is for suppressing the wavefront generated by the boundaries of all polygons when the source type is Reflector. Selection of the source type is described in the Section ***7.1***.

5.7 Order of polygon overlapping

All the polygons in the model are displayed in the same order as they appear in the polygon's list (the list in the main editing toolbar). Please use the menu command `Model > Bring Polygon Forward` to move a polygon upward, and use the menu command `Model > Bring Polygon Backward` to move a polygon downward. These commands move the polygon up/down one level, i.e. exchange the chosen polygon and the previous or next one. To set the correct order of overlapping polygons, users may need to repeat this command several times.

5.8 Base points

The base points are used to specify the components with linear gradient within the polygon. Firstly, select the polygon where you would like to add some base points. To add a base point to an active (selected) polygon, please choose the command `Add Base Point` in the context menu by clicking the right mouse button, or select the command in the menu `Model > Base Points > Add Base Point`.


Base Point

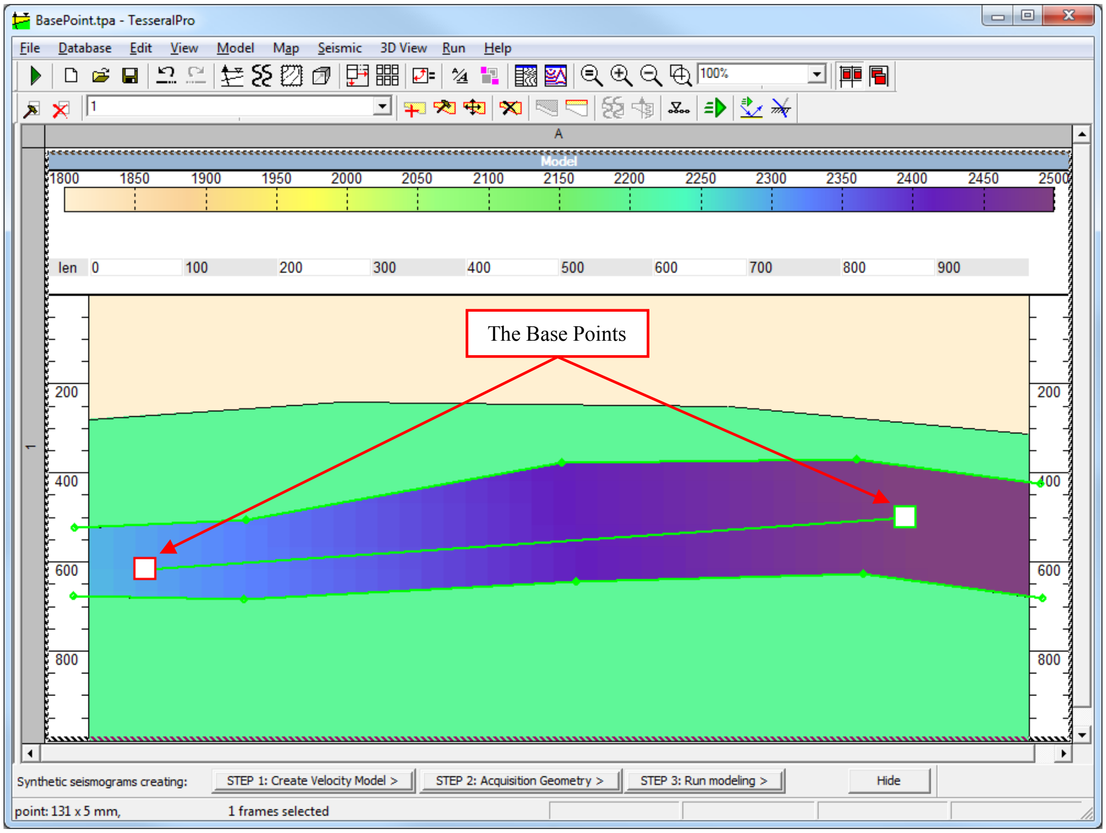
Component	Units	Manually	Value
Compressional velocity	m/s	☑	2200
Density	kg/m^3	☐	2086
Shear velocity	m/s	☐	1270

Coordinate

Distance (X) 500 m

Depth (Z) 500 m

Please specify the coordinates of the base points and the values of each component in the dialogue box `Base Point`. The gradient will be calculated automatically for any 2 adjacent base points:


BasePoint.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
Model
1800 1850 1900 1950 2000 2050 2100 2150 2200 2250 2300 2350 2400 2450 2500
len 0 100 200 300 400 500 600 700 800 900
200
400
600
800
The Base Points
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

point: 131 x 5 mm, 1 frames selected

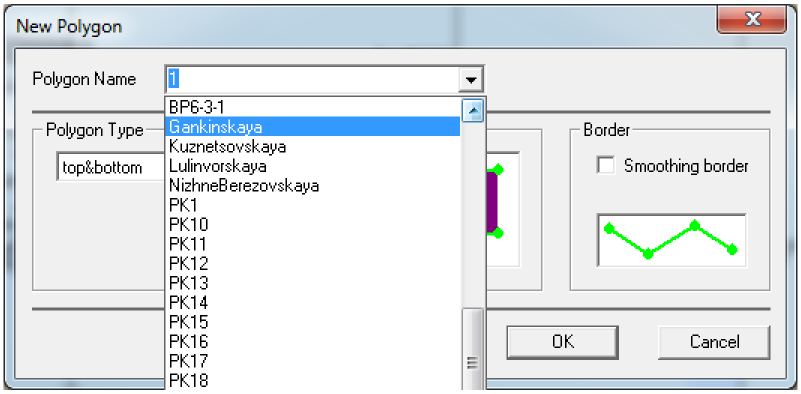
To edit the parameters at a base point, please use the `Edit Base Point` command in context menu by right-clicking the base point or use the menu command `Model > Base`

`Points > Edit Base Point` for the active base point marked by square with red edge. The base points may be relocated by the mouse (press-drag-release) or deleted by using the command `Delete Base Point` in the context menu or `Model > Base Points > Delete Base Point` in the to-level menu.

5.9 Build polygons from well’s intersection data

This feature is supported only for models built using wells with layers. Please see Section *4.5* for details about building models using well data.

Select the `Model` Frame and then select the command `Create polygon`. In the dialogue box `New Polygon`, specify the `Polygon Name` from the list of layer’s codes in the database. These polygons need to have been created in advance using Top and Bottom Markers and be saved in the Database.


New Polygon

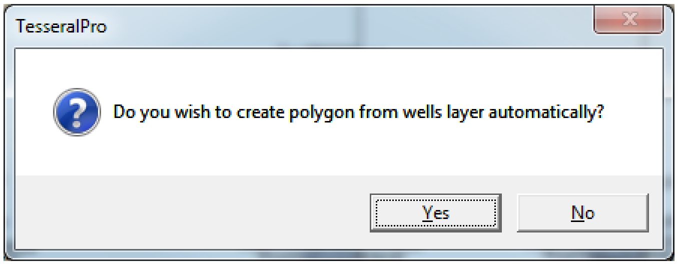
Polygon Name: 1

Polygon Type: top&bottom

Border: ☐ Smoothing border

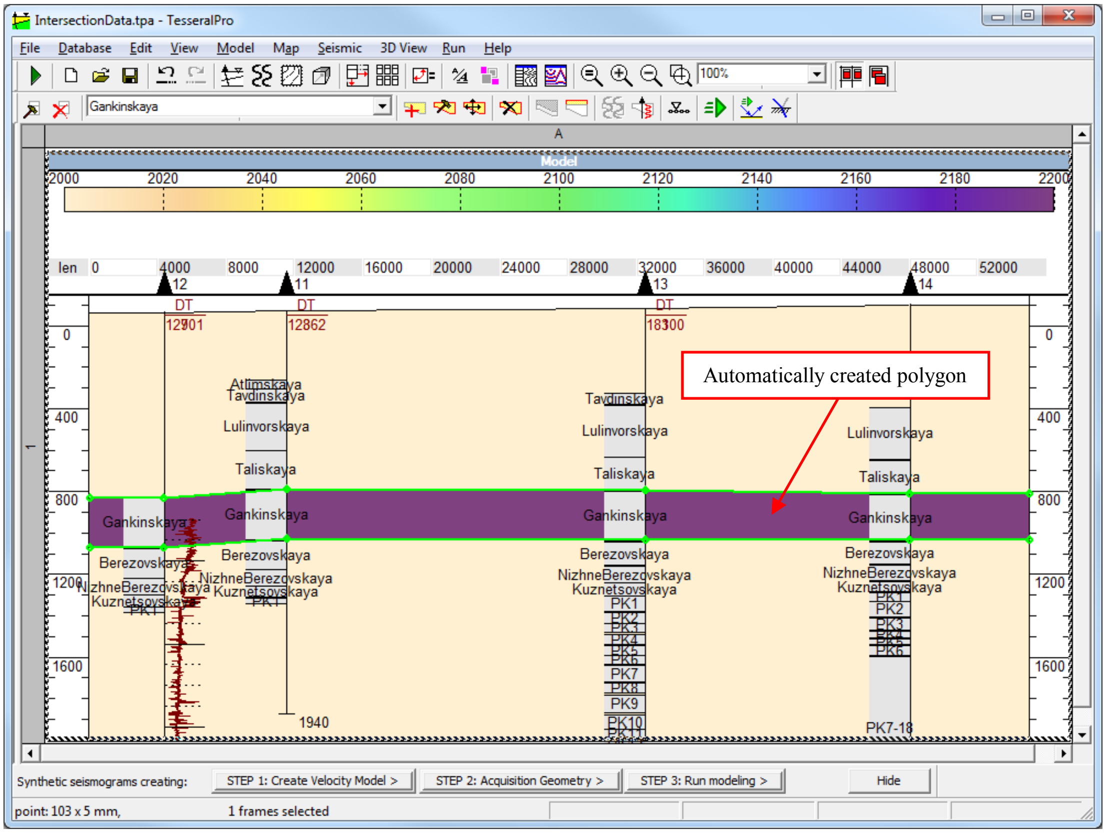
BP6-3-1
Gankinskaya
Kuznetsovskaya
Lulinvorskaya
NizhneBerezovskaya
PK1
PK10
PK11
PK12
PK13
PK14
PK15
PK16
PK17
PK18
OK
Cancel

If the name of a polygon matches at least one of layer names for the wells loaded into the model, you will be asked to build the polygon automatically from the layer intersection data.


TesseralPro

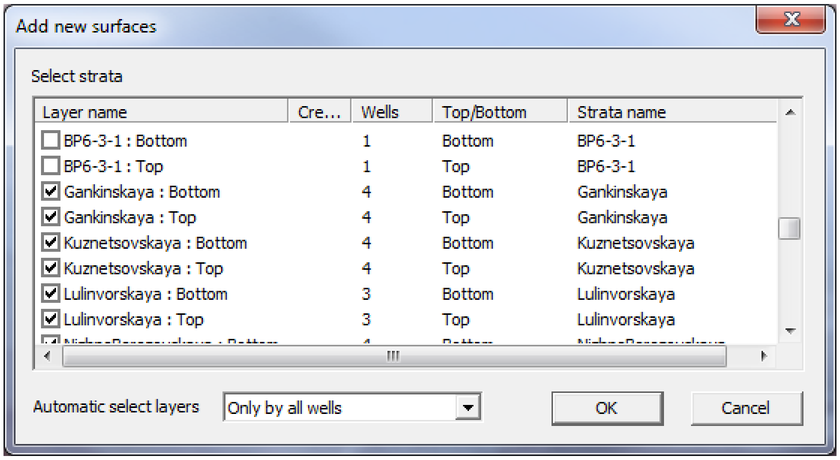
Do you wish to create polygon from wells layer automatically?

Please see the results:


IntersectionData.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Gankinskaya
A
Model
2000 2020 2040 2060 2080 2100 2120 2140 2160 2180 2200
len 0 4000 8000 12000 16000 20000 24000 28000 32000 36000 40000 44000 48000 52000
12
11
13
14
DT
12901
12862
18300
0
400
800
1200
1600
Atlimskaya
Tavdinskaya
Lulinvorskaya
Taliskaya
Gankinskaya
Berezovskaya
NizhneBerezovskaya
Kuznetsovskaya
PK1
PK2
PK3
PK4
PK5
PK6
PK7
PK8
PK9
PK10
PK7-18
1940
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 103 x 5 mm,
1 frames selected

Automatically created polygon

The automatic creation of a polygon group from several selected layers is supported, for which the menu command `Model > Wells & Polygons > Create Polygons from Well Strata Marks` is used.



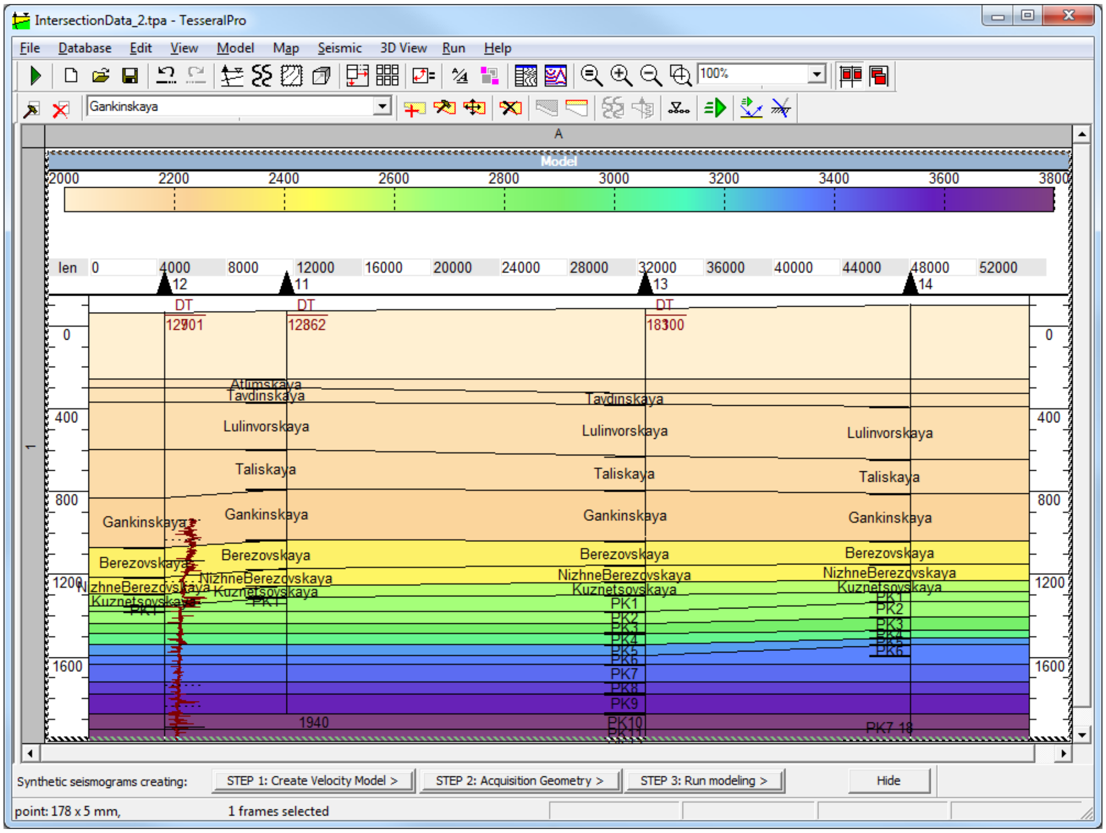
Add new surfaces

Select strata

Layer name	Cre...	Wells	Top/Bottom	Strata name
☐ BP6-3-1 : Bottom		1	Bottom	BP6-3-1
☐ BP6-3-1 : Top		1	Top	BP6-3-1
☑ Gankinskaya : Bottom		4	Bottom	Gankinskaya
☑ Gankinskaya : Top		4	Top	Gankinskaya
☑ Kuznetsovskaya : Bottom		4	Bottom	Kuznetsovskaya
☑ Kuznetsovskaya : Top		4	Top	Kuznetsovskaya
☑ Lulinvorskaya : Bottom		3	Bottom	Lulinvorskaya
☑ Lulinvorskaya : Top		3	Top	Lulinvorskaya

Automatic select layers: Only by all wells

From the list of layers, select the ones you would like to see enclosed with polygons. The result will be a depth model created automatically.

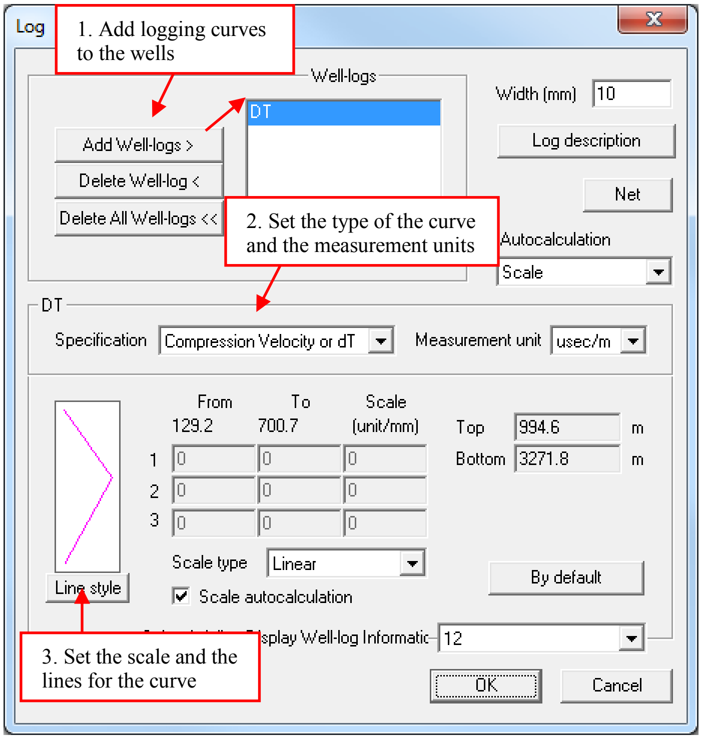

IntersectionData_2.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Gankinskaya
A
Model
2000 2200 2400 2600 2800 3000 3200 3400 3600 3800
len 0 4000 8000 12000 16000 20000 24000 28000 32000 36000 40000 44000 48000 52000
12
11
13
14
DT
12901
12862
18300
0
400
800
1200
1600
Atlimskaya
Tavdinskaya
Lulinvorskaya
Taliskaya
Gankinskaya
Berezovskaya
NizhneBerezovskaya
Kuznetsovskaya
PK1
PK2
PK3
PK4
PK5
PK6
PK7
PK8
PK9
PK10
PK11
1940
PK7 18
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 178 x 5 mm,
1 frames selected

5.10 Build polygons from well logs (thin layering)

Tesseral Pro has the capability of building a thin-layered velocity model from well log data (particularly using acoustic log).

> **NOTE**: To build a thin-layered model from well log data, it is recommended to start the process using the Wizard for model creation `From database WELLS`. Please see details in the Section *4.5*.

STEP 1. Select the acoustic logs. Please select the acoustic logs (DT or AK) in the dialogue box `Model Properties` for the Model created by well data. To do this, check the checkbox near the `Log` button on the right hand side of the `Well data` group to the left or right of the well. Then click the `Log` button, and in the pop-up dialogue box `Log`, select the needed acoustic logs from the list of all well logs loaded into this model. To specify the polygon parameters from well log data correctly, please select `Compressional Velocity or dT` in the `Specification` parameter list, and `usec/m` as `Measurement unit` parameter for the selected logs.



1. Add logging curves to the wells

2. Set the type of the curve and the measurement units

3. Set the scale and the lines for the curve

Width (mm) 10

Autocalculation: Scale

Specification: Compression Velocity or dT

Measurement unit: usec/m

From 129.2 To 700.7

Top 994.6 m

Bottom 3271.8 m

Scale type: Linear

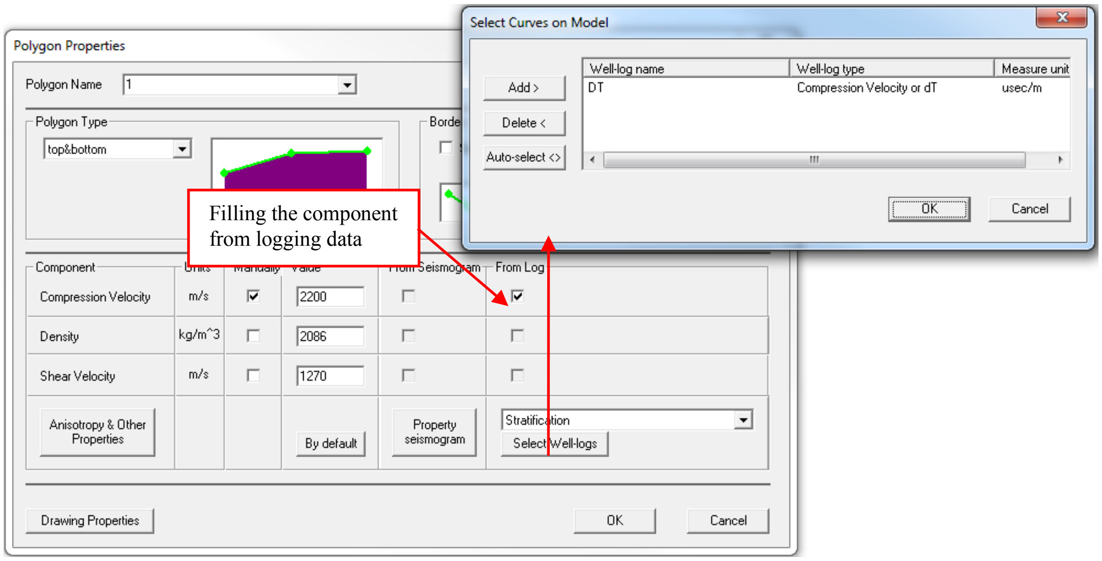
☑ Scale autocalculation

…splay Well-log Informatic 12

After that, the well logs will be shown near the wells in the model.

STEP 2. Build polygon. The common “thick” polygons are used for the thin-layered models. These polygons may be built either manually (see Section *5.1*) or by any of the automatic methods (see the Section *5.9* and the Section *14.2.7*).

STEP 3. Set polygon components from logs (`From Log`). Please select a polygon and then choose the menu command `Model > Edit Polygon`. If the acoustic logs are selected correctly (see **STEP 1**), the `From Log` checkbox should be enabled for the `Compressional velocity` component. Check this checkbox (`From Log)`.

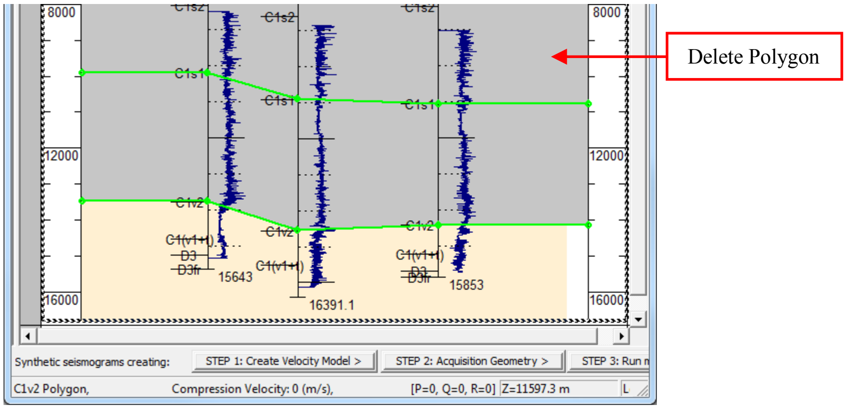

Polygon Properties
Polygon Name 1
Polygon Type top&bottom
Border
Component Units Manually Value From Seismogram From Log
Compression Velocity m/s ☑ 2200 ☐ ☑
Density kg/m^3 ☐ 2086 ☐ ☐
Shear Velocity m/s ☐ 1270 ☐ ☐
Anisotropy & Other Properties
By default
Property seismogram
Stratification
Select Well-logs
Drawing Properties
OK
Cancel
Select Curves on Model
Add >
Delete <
Auto-select <>
Well-log name Well-log type Measure unit
DT Compression Velocity or dT usec/m
OK
Cancel

Filling the component from logging data

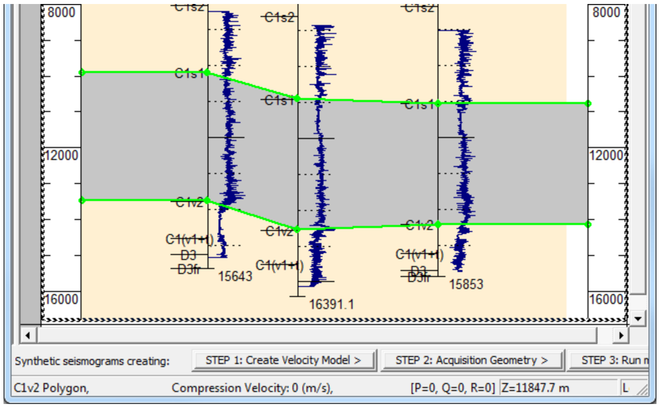
NOTE: If the selection `From Log` is not enabled (is grayed), click `Select Well-logs` to select the correct acoustic logs into the model.

NOTE: After checking the `From Log` checkbox and clicking `OK`, the interpolation calculation for the components won't start immediately. And the `From Log` component value will overwrite the default value when the calculation starts.

If the steps above are done correctly, you will see the result similar to the figures below. To get the second picture you need to delete the upper polygon using "Delete Polygon" button.

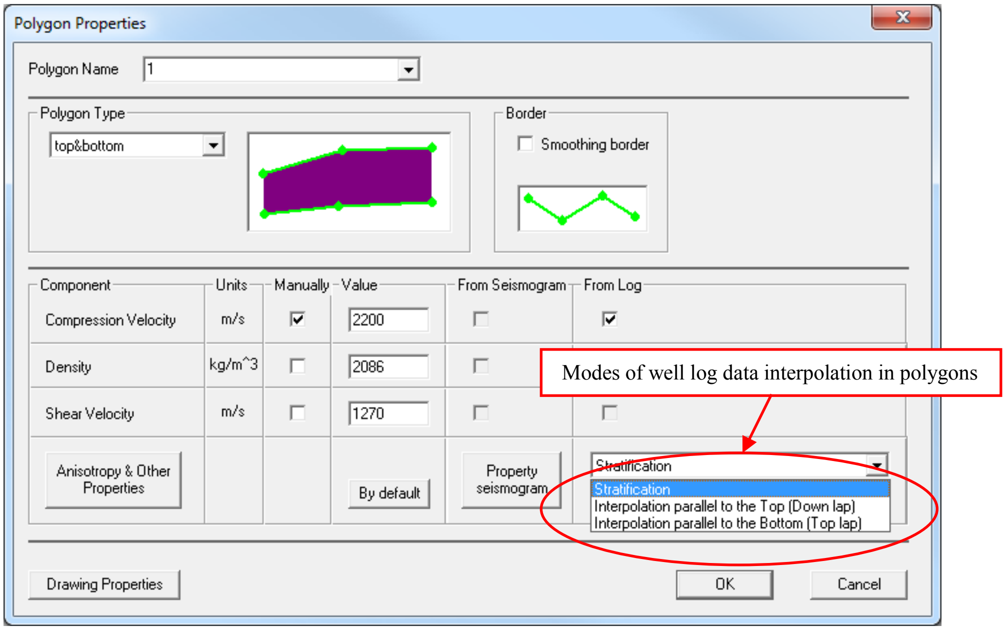

8000
12000
16000
C1s2
C1s1
C1v2
C1(v1+l)
D3
D3fr
15643
16391.1
15853
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run
C1v2 Polygon,
Compression Velocity: 0 (m/s),
[P=0, Q=0, R=0]
Z=11597.3 m

Delete Polygon


8000
12000
16000
C1s2
C1s1
C1v2
C1(v1+l)
D3
D3fr
15643
16391.1
15853
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run
C1v2 Polygon,
Compression Velocity: 0 (m/s),
[P=0, Q=0, R=0]
Z=11847.7 m

Polygon specifics while using well logs

The parameters of polygons built from well logs are calculated by interpolating the well log data along the layer. There are 3 modes of interpolation:


Polygon Properties
Anisotropy & Other Properties
By default
Property seismogram
Drawing Properties
OK
Cancel
Stratification
Interpolation parallel to the Top (Down lap)
Interpolation parallel to the Bottom (Top lap)

Polygon Name: 1

Polygon Type: top&bottom

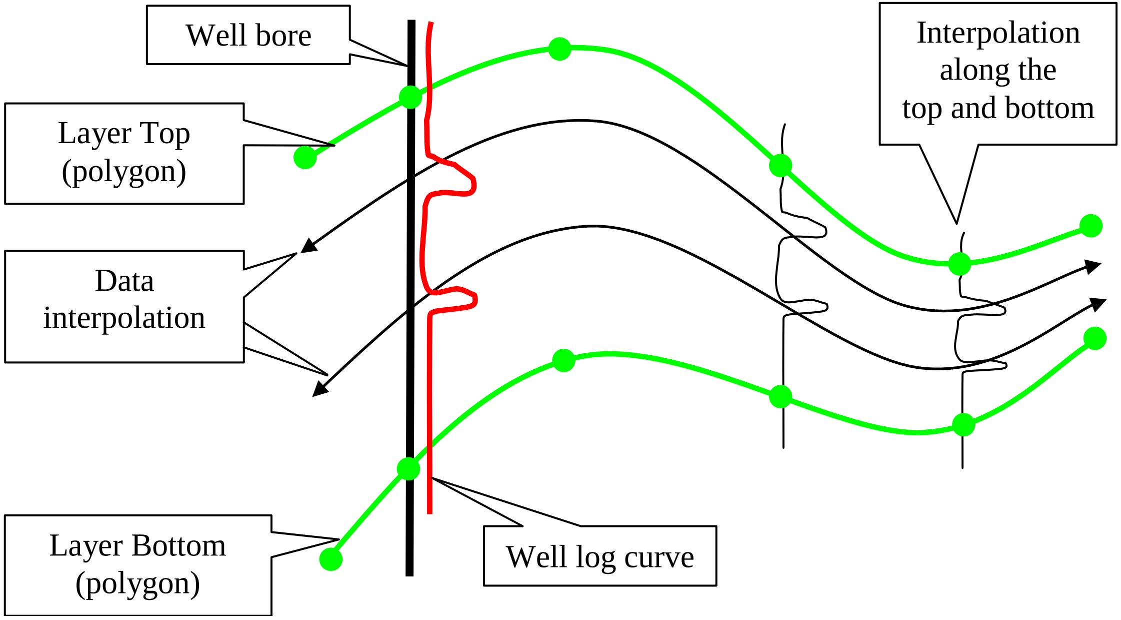
Border: ☐ Smoothing border

Component	Units	Manually	Value	From Seismogram	From Log
Compression Velocity	m/s	☑	2200	☐	☑
Density	kg/m^3	☐	2086	☐	
Shear Velocity	m/s	☐	1270	☐	☐

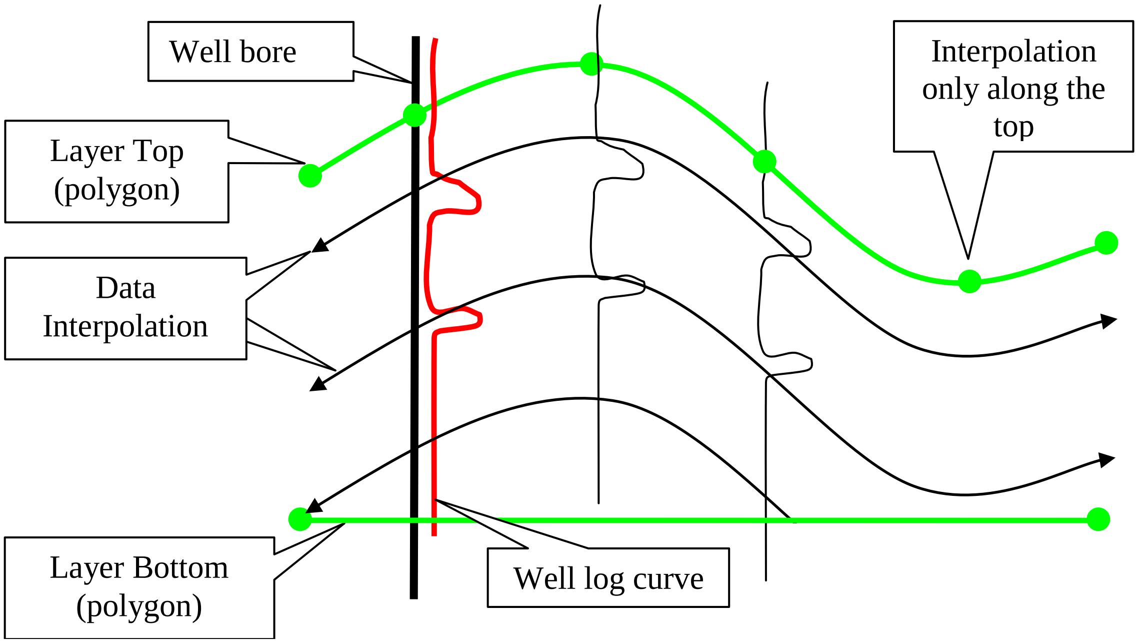
From Log: Stratification

Modes of well log data interpolation in polygons

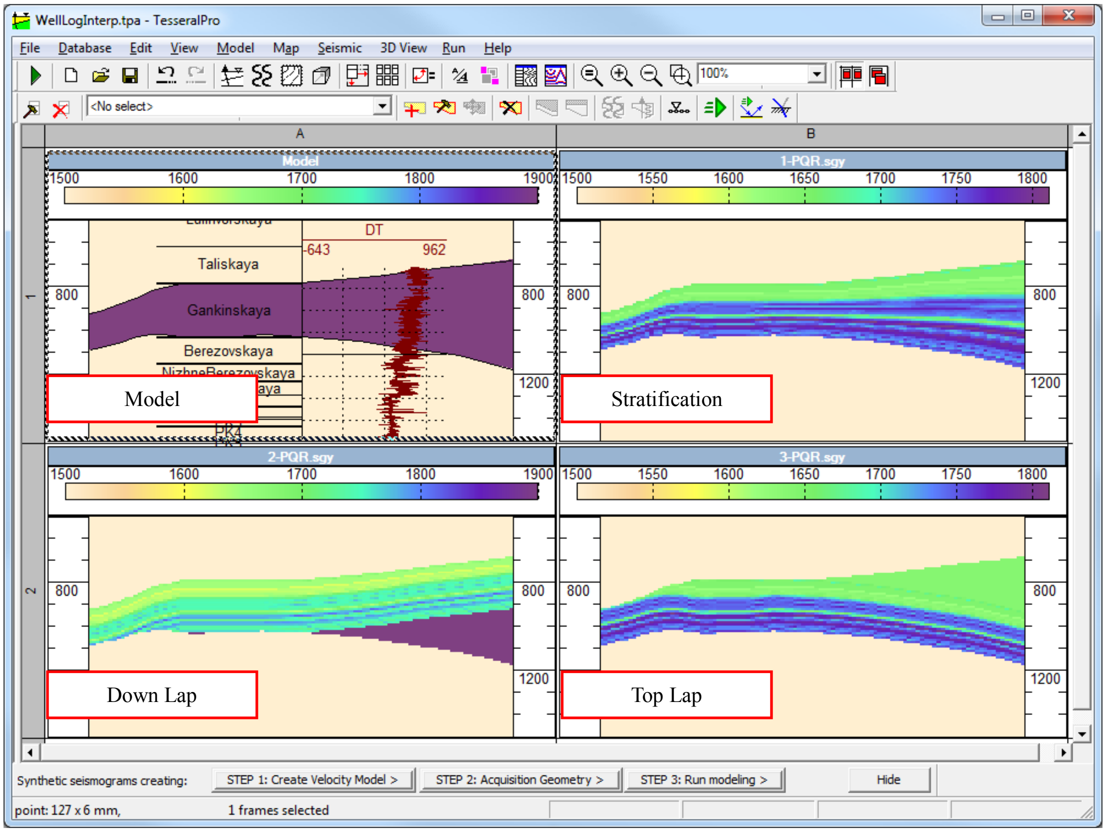
- `Stratification`: uniform compression. Stretching is proportional to the layer's thickness.


Well bore
Interpolation along the top and bottom
Layer Top (polygon)
Data interpolation
Layer Bottom (polygon)
Well log curve

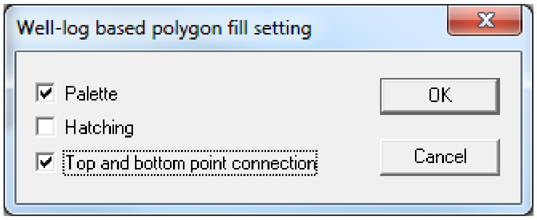
- `Interpolation parallel to the Top (Down lap)`: The data interpolation will be "parallel" to the "Top" boundary of polygon.


Well bore
Interpolation only along the top
Layer Top (polygon)
Data Interpolation
Layer Bottom (polygon)
Well log curve

- `Interpolation parallel to the Bottom (Top lap)`: The data interpolation will be “parallel” to the “Bottom” boundary of polygon.


WellLogInterp.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
<No select>
A
B
Model
1500 1600 1700 1800 1900
1-PQR.sgy
1500 1550 1600 1650 1700 1750 1800
Taliskaya
Gankinskaya
Berezovskaya
NizhneBerezovskaya
DT
643
962
800
1200
Model
Stratification
2-PQR.sgy
3-PQR.sgy
Down Lap
Top Lap
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 127 x 6 mm,
1 frames selected

To display the parameters of the polygons that were obtained using logs, please use the menu command `Model > Wells & Polygons > Well-Log Based Polygon Fill Options`.



Well-log based polygon fill setting

☑ Palette

☐ Hatching

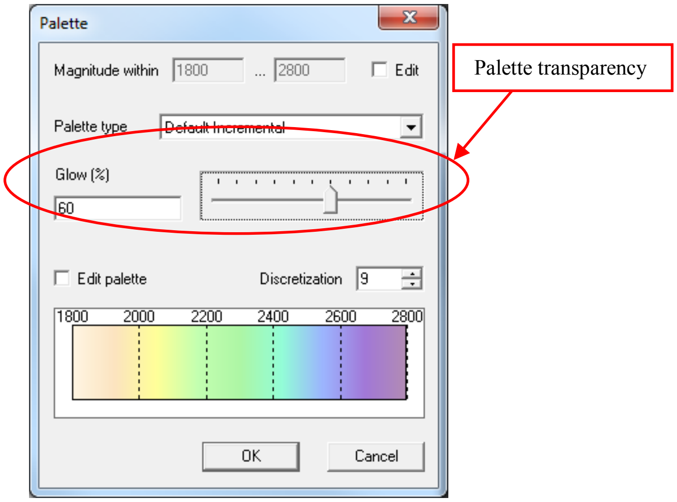
☑ Top and bottom point connection

5.11 Build model from 2D/3D gathers

Tesseral Pro allows building a model by importing velocity models having the following formats: SEG-Y, SDS-PC, and TGR. A seismic model can be used during building of polygons as underlay or as a filling source for the polygons created by velocities.

> **NOTE**: To build a model by gathers, it is recommended first to prepare it by the Wizard for building a model `From SEISMIC file`. Please see details in the Section *4.3*.

While building the polygons, please use the seismic underlying image as a background "picture"; it is also recommended to adjust the model transparency using the command `Edit > Palette`.



Magnitude within 1800 ... 2800 ☐ Edit

Palette type Default Incremental

Glow (%) 60

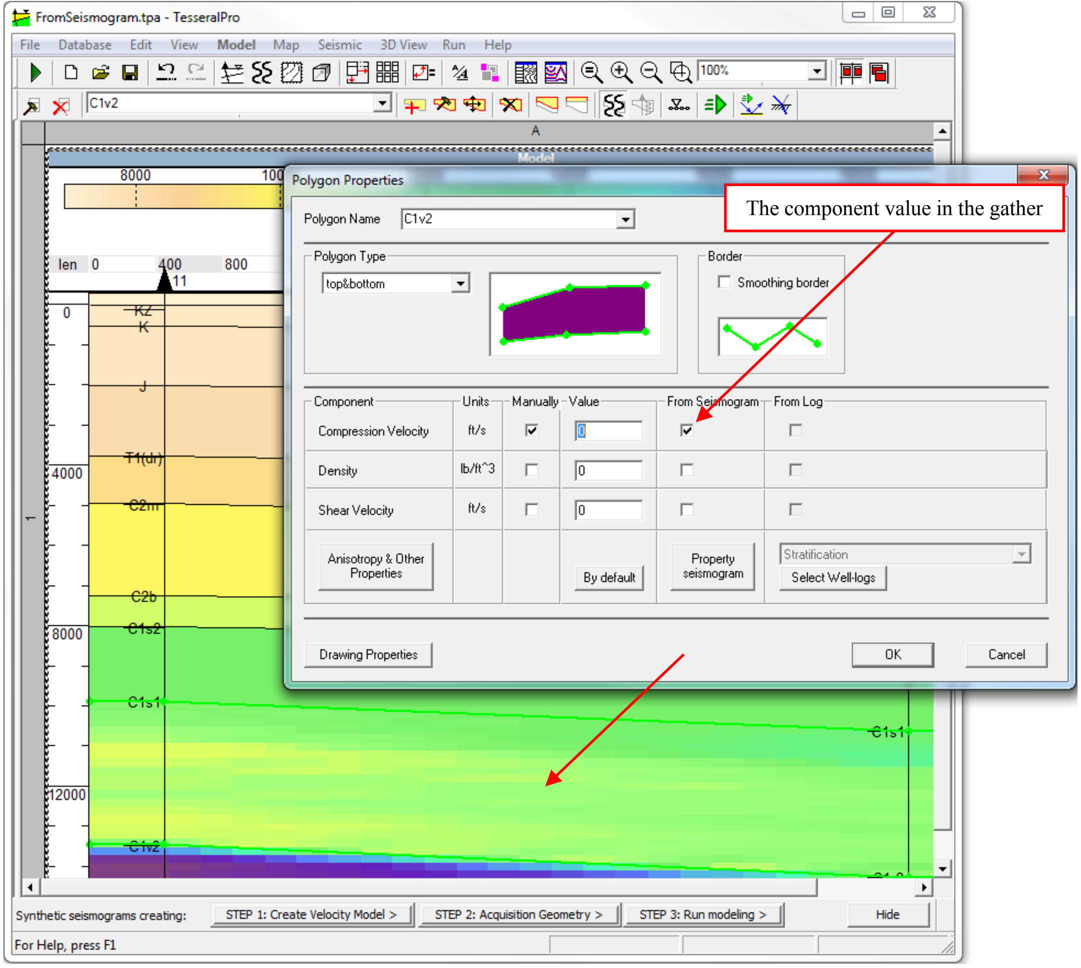
☐ Edit palette

Discretization 9

Palette transparency

5.12 Specify the polygon’s components by underlying gather

In the dialogue box with polygon parameters (the menu command `Model > Edit Polygon`), please define the option `From Seismogram` for any component. The `From Seismogram` button will be disabled (gray) if an underlying gather is not defined or if a component is not selected for the gather (please see details in the Section *4.3*).


FromSeismogram.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
C1v2
A
Model
8000
len 0 400 800
11
KZ
K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2
0
4000
8000
12000
Polygon Properties
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1
Anisotropy & Other Properties
By default
Property seismogram
Select Well-logs
Drawing Properties
OK
Cancel

Polygon Name: C1v2

Polygon Type: top&bottom

Border: ☐ Smoothing border

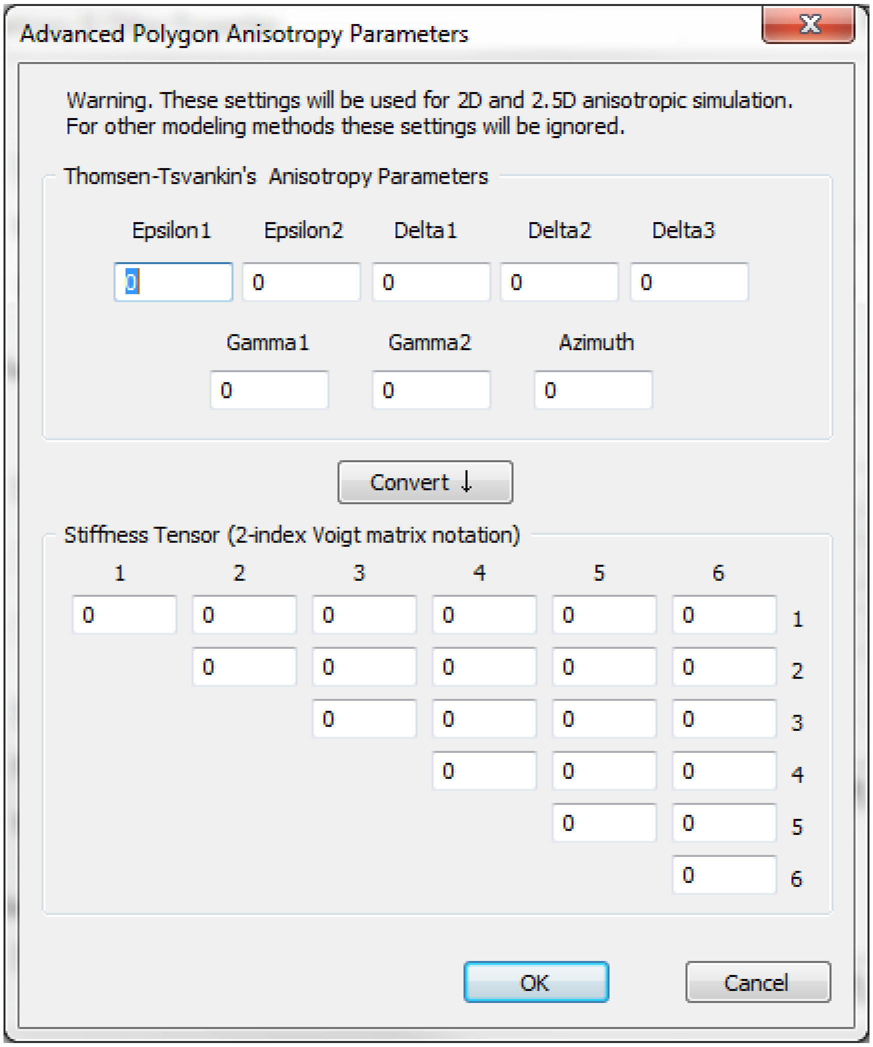
Component	Units	Manually	Value	From Seismogram	From Log
Compression Velocity	ft/s	☑	0	☑	☐
Density	lb/ft^3	☐	0	☐	☐
Shear Velocity	ft/s	☐	0	☐	☐

Stratification

The component value in the gather

5.13 Thomson- Tsvankin's Anisotropy Parameters

It also now possible to run 2.5D Elastic Modelling for mediums with orthorhombic anisotropy. An orthorhombic medium can be described by 7 dimensionless Thomson-Tsvankin parameters. They can be accessed in `Polygon Properties > Anisotropy & Other Properties >Thomson's Tsvankin parameters`



Advanced Polygon Anisotropy Parameters

Warning. These settings will be used for 2D and 2.5D anisotropic simulation.
For other modeling methods these settings will be ignored.

Thomsen-Tsvankin's Anisotropy Parameters

Epsilon1	Epsilon2	Delta1	Delta2	Delta3
0	0	0	0	0

Gamma1	Gamma2	Azimuth
0	0	0

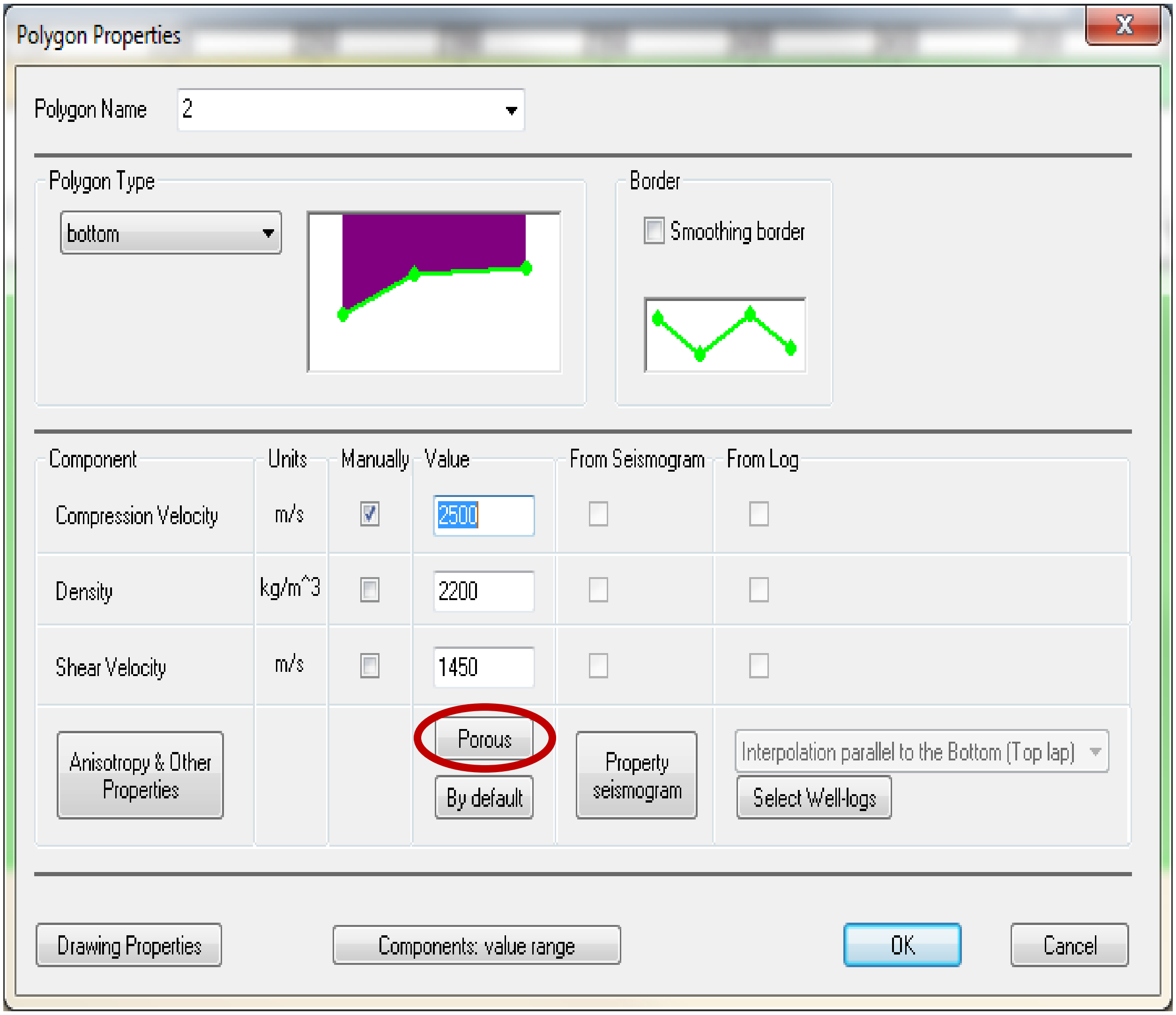
Stiffness Tensor (2-index Voigt matrix notation)

1	2	3	4	5	6	
0	0	0	0	0	0	1
	0	0	0	0	0	2
		0	0	0	0	3
			0	0	0	4
				0	0	5
					0	6

In the `Advanced Polygon Anisotropy Parameters` window the user can either specify the `Thomson-Tsvankin's Anisotropy Parameters` and calculate the Elastic Stiffness Coefficients or directly specify the `Stiffness Tensor` for the chosen polygon.

5.14 Porous Medium Parameters

The user can now specify the porous medium parameters for any polygon in the model. In order to access these parameters- right click on the polygon of interest and select `Edit Polygon > Porous`



Polygon Name: 2

Polygon Type: bottom

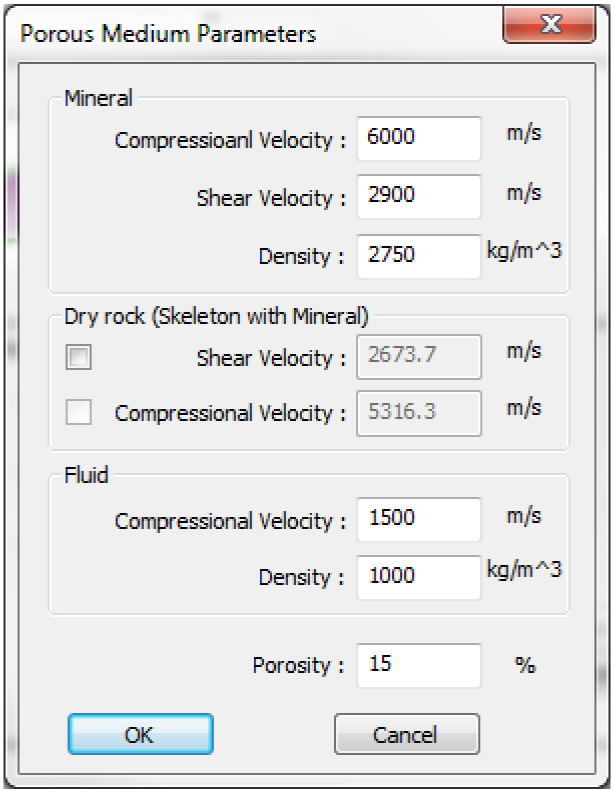
Border: ☐ Smoothing border

Component	Units	Manually	Value	From Seismogram	From Log
Compression Velocity	m/s	☑	2500	☐	☐
Density	kg/m^3	☐	2200	☐	☐
Shear Velocity	m/s	☐	1450	☐	☐

Interpolation parallel to the Bottom (Top lap)

Polygon Properties
X
Anisotropy & Other Properties
Porous
By default
Property seismogram
Select Well-logs
Drawing Properties
Components: value range
OK
Cancel

Once the `Porosity` is specified, along with the elastic wave velocities and density for the `Mineral`, `Dry Rock` and `Fluid`, the saturated rock velocities and bulk density in `Polygon properties` window will change accordingly(i.e. based on Gassman's equation).



Porous Medium Parameters

Mineral

Compressioanl Velocity : 6000 m/s

Shear Velocity : 2900 m/s

Density : 2750 kg/m^3

Dry rock (Skeleton with Mineral)

☐ Shear Velocity : 2673.7 m/s

☐ Compressional Velocity : 5316.3 m/s

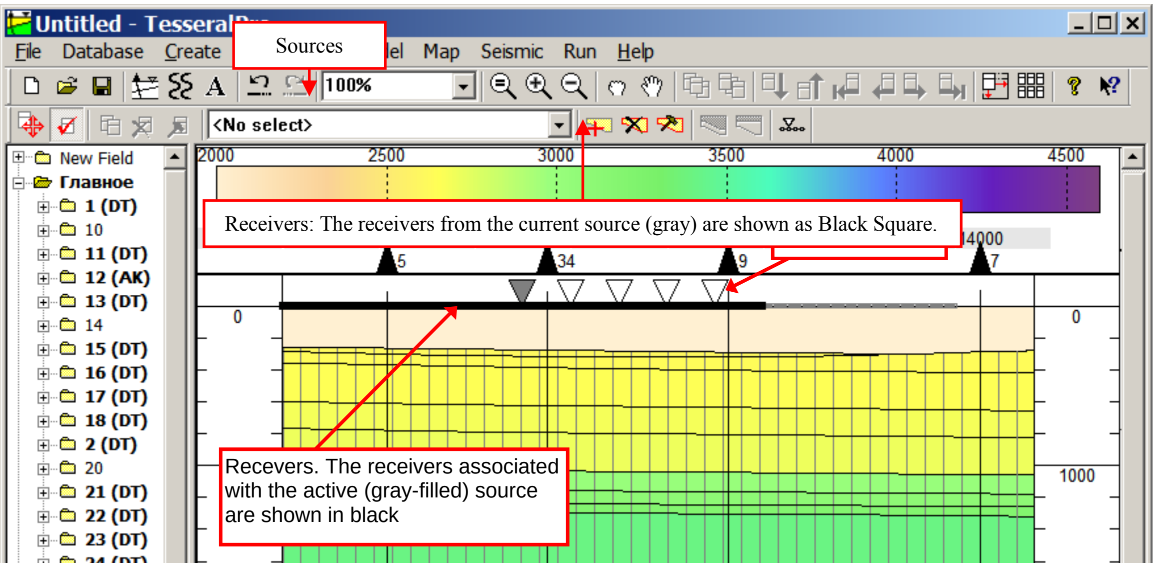
Fluid

Compressional Velocity : 1500 m/s

Density : 1000 kg/m^3

Porosity : 15 %

6 Acquisition geometry


Untitled - TesseralPro
File
Database
Create
el
Map
Seismic
Run
Help
100%
<No select>
New Field
Главное
1 (DT)
10
11 (DT)
12 (AK)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
2000
2500
3000
3500
4000
4500
4000
5
34
9
7
0
0
1000

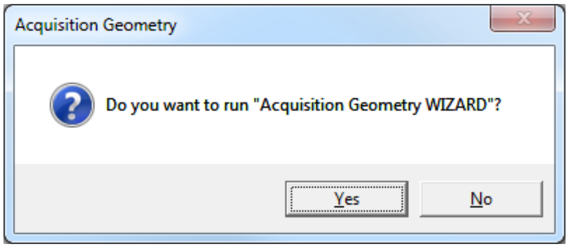
Sources

Receivers: The receivers from the current source (gray) are shown as Black Square.

Recevers. The receivers associated with the active (gray-filled) source are shown in black

Sources are shown as triangles. To make a source active (selected) in the `Model` Frame, click it with the left mouse button. The active source will be filled in grey color. The receivers associated with the active source are shown as black squares. The other receivers are shown as grey squares. To move sources or receivers manually, use the mouse by pressing-dragging-releasing.

The spread of sources (shot points) and receivers (receiving points) are designed by choosing `Model > Acquisition Geometry` menu command. In the dialogue box, the number of sources/receivers, their intervals and positions can be specified, and every source can be associated with a group of receivers. The users will be offered to arrange the sources/receivers geometry using a Wizard.


Acquisition Geometry
Yes
No

Do you want to run "Acquisition Geometry WIZARD"?

Since it is quite complicated to adjust the spread manually, it is recommended to use the Wizard.

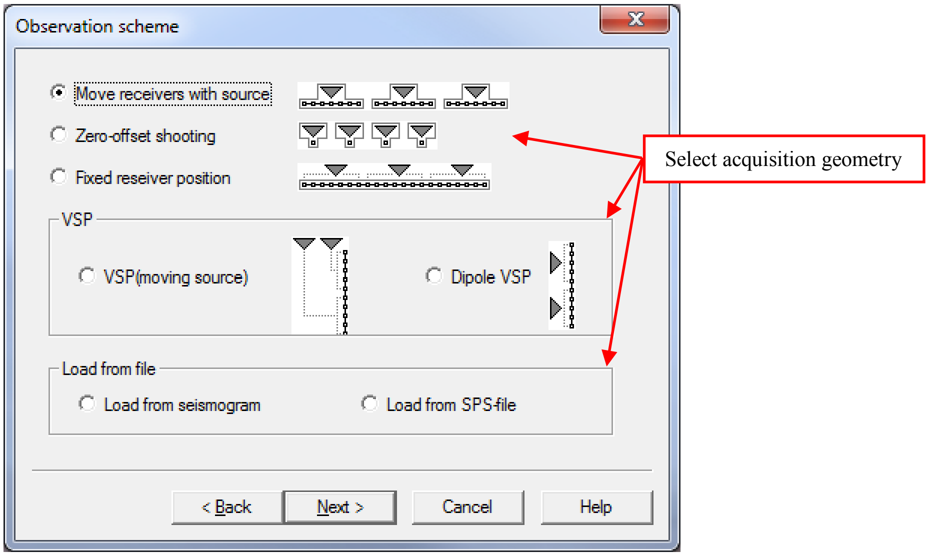
> NOTE: The dialogue box `Acquisition Geometry` Wizard is always launched at the very beginning of model creation.

In the Tesseral Pro, several acquisition design schemes can be implemented. Depending on the selected scheme, the Wizard may have 1~4 dialogue boxes.

6.1 Receivers move with source

The receivers are positioned in relation to one of the sources, and then they are repeated for other sources of the model.

STEP 1. Acquisition geometry


Observation scheme

● Move receivers with source
○ Zero-offset shooting
○ Fixed reseiver position

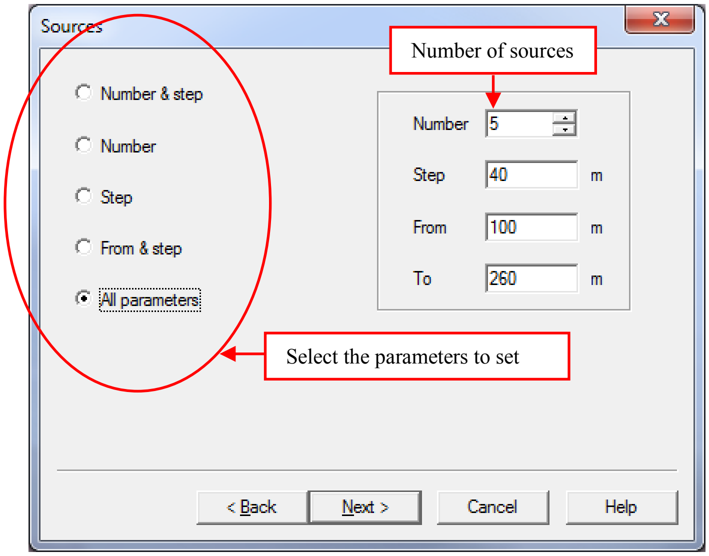
VSP
○ VSP(moving source)
○ Dipole VSP

Load from file
○ Load from seismogram
○ Load from SPS-file

Select acquisition geometry

In the dialogue box `Observation scheme`, please select `Move receivers with source`. When this mode is chosen, you should first provide the source layout, followed by the layout of receives *relative to the same source*. As a result the receiver spread will have the same distribution for every single source.

STEP 2. Sources – In the dialogue box `Sources`, please select the set of parameters to be set from the list, and then enter the values for each empty parameter cell. The sources will be automatically placed uniformly along the acquisition surface (above the top edge of the model polygons).


Sources

○ Number & step
○ Number
○ Step
○ From & step
● All parameters

Number 5
Step 40 m
From 100 m
To 260 m

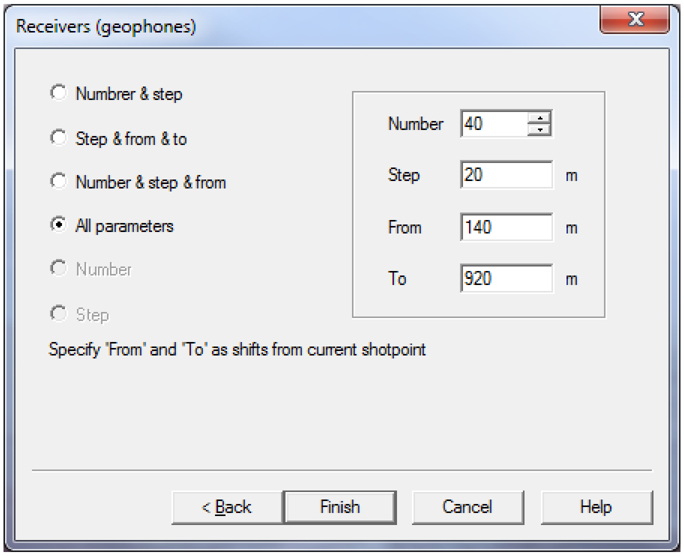
Number of sources

Select the parameters to set

`From` – is the starting position of the source line along the model section (profile)
`To` – is the ending position of the source line along the model section (profile)
`Step` – source interval
`Number` – number of sources

NOTE: These parameters are related with each other by a simple relation: Number = To –From / Step + 1. Therefore, changing one of these parameters leads to recalculation of others.

STEP 3. **Receivers** (for the acquisition geometry “Move receivers with source”**)**



Receivers (geophones)

○ Numbrer & step
○ Step & from & to
○ Number & step & from
● All parameters
○ Number
○ Step

Number: 40
Step: 20 m
From: 140 m
To: 920 m

Specify 'From' and 'To' as shifts from current shotpoint

Specify the receiver distribution in the dialogue box `Receivers (geophones)`. The parameters `From` and `To` do not represent the absolute distance relative to the profile origin, but the relative shift with respect to its corresponding source (negative value means placement to the left of its respective source).

6.2 Receivers at fixed position

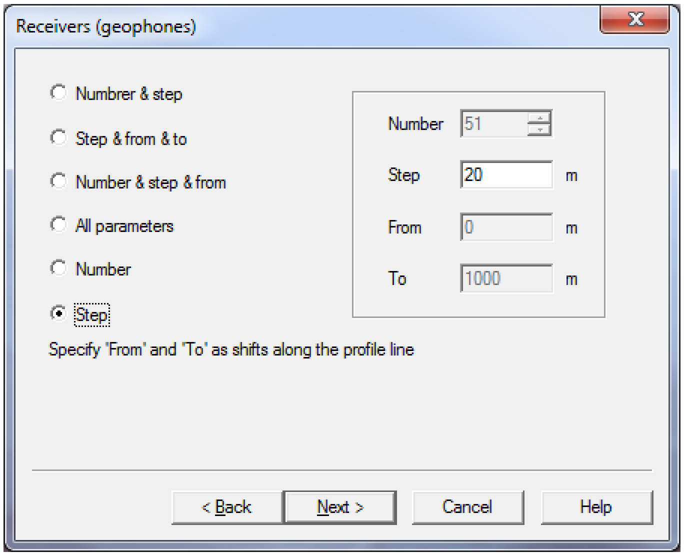
The receivers and the sources are positioned independently. Thus, for each source, a group of receivers have to be selected.

STEP 1. Acquisition geometry

In the dialogue box `Observation scheme`, please select `Fixed receiver position`. In the following dialogue box, you should specify the source line independently, and then specify the group of receivers for each source.

STEP 2. Sources (for the acquisition geometry **"**Fixed receiver position**")** – The dialogue box `Sources` is the same for all types of acquisition geometries. More detailed information is given above.

STEP 3. Receivers (for the acquisition geometry **"**Fixed receiver position**")**


Receivers (geophones)

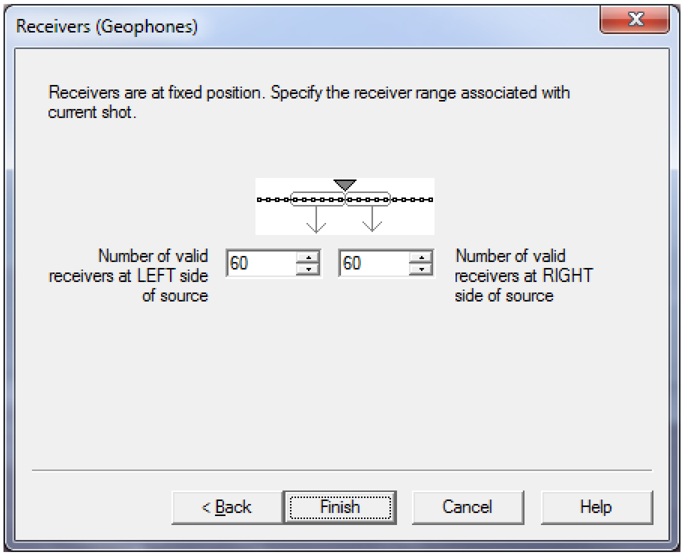
○ Numbrer & step
○ Step & from & to
○ Number & step & from
○ All parameters
○ Number
● Step

Number 51
Step 20 m
From 0 m
To 1000 m

Specify 'From' and 'To' as shifts along the profile line

For the scheme "Fixed receiver position", the dialogue box `Receivers (geophones)` is similar to the dialogue box `Sources`. The parameters `From` and `To` specify distance along the profile line of the model. Please see the detailed description (for the dialogue box `Sources`) above.

Please specify the number of receivers (from the whole receiver line) used both to the left and to the right of the source.


Receivers (Geophones)

Receivers are at fixed position. Specify the receiver range associated with current shot.

Number of valid receivers at LEFT side of source 60

Number of valid receivers at RIGHT side of source 60

6.3 Zero offset

In this scheme, each source has only one receiver with the same coordinates. It is mainly used for ray tracing.

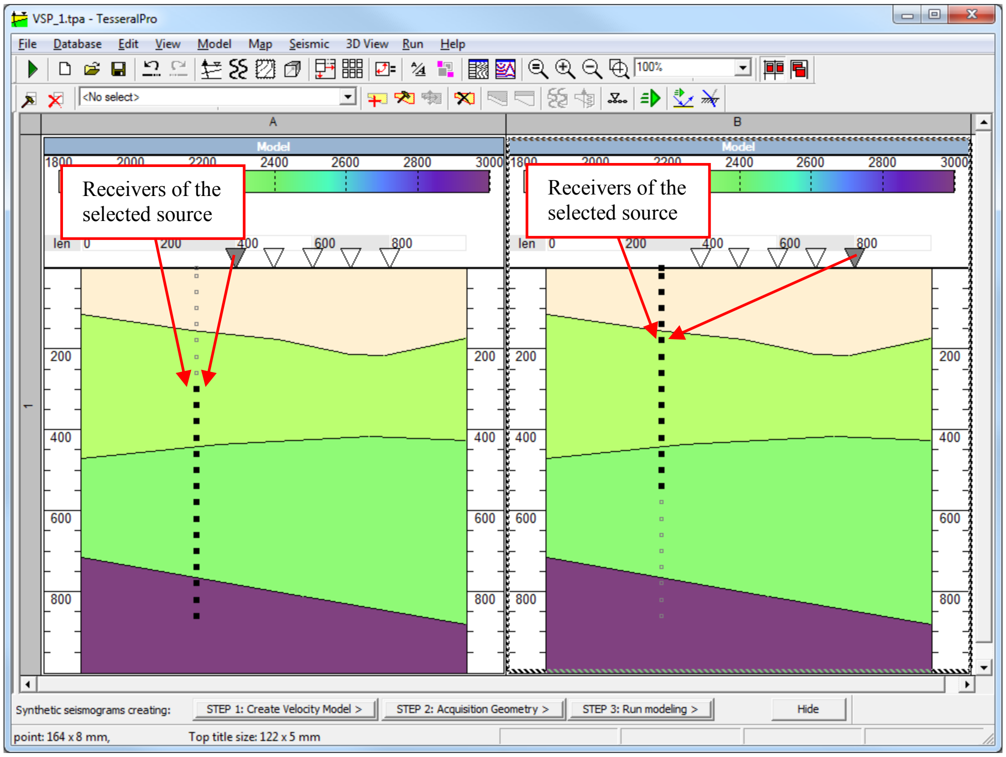
STEP 1. Acquisition geometry

In the dialogue box `Observation scheme`, please select the option `Zero-offset shooting`. In the next dialogue box, you should specify the source line. Receivers will be positioned automatically in a way that only one receiver is assigned to each source and the coordinates of each receiver will be identical to its corresponding source.

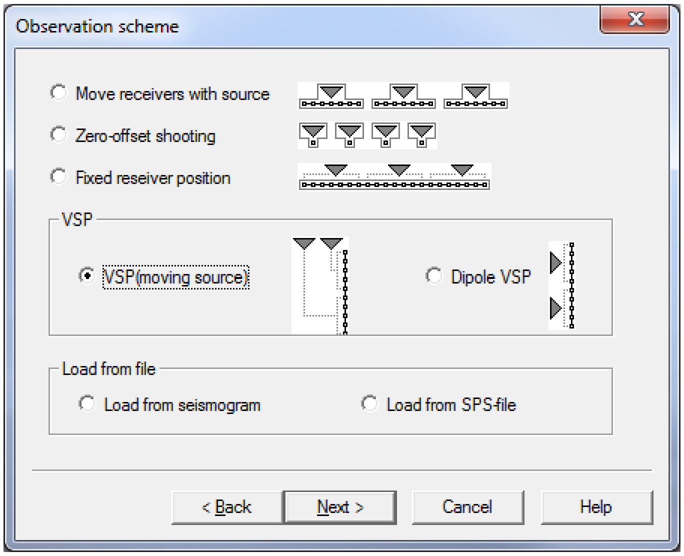
STEP 2. Sources (for the acquisition geometry **"**Zero-offset shooting**")** – The dialogue box `Sources` is the same for all the acquisition geometries. The more detailed description can be found in the Section ***6.1***.

6.4 VSP and VSP with ascending receivers

It is used for designing VSP acquisition geometry for the case when all sources are located on the surface. The receiver line can be fixed or ascending inside the well.


VSP_1.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
<No select>
A
B
Model
1800 2000 2200 2400 2600 2800 3000
Receivers of the selected source
Receivers of the selected source
len 0 200 400 600 800
200
400
600
800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 164 x 8 mm,
Top title size: 122 x 5 mm

STEP 1. Acquisition scheme – In the dialogue box Observation scheme, select VSP(moving source).


Observation scheme
< Back
Next >
Cancel
Help

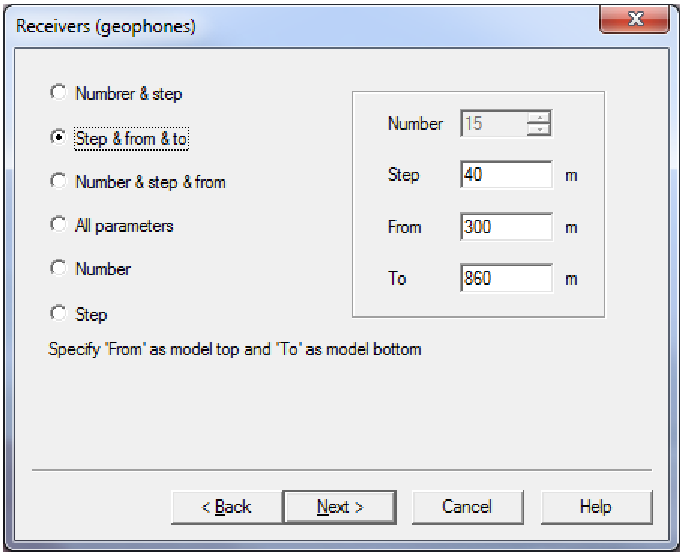
○ Move receivers with source
○ Zero-offset shooting
○ Fixed reseiver position

VSP
● VSP(moving source)
○ Dipole VSP

Load from file
○ Load from seismogram
○ Load from SPS-file

STEP 2. Sources – The dialogue box Sources is similar to other acquisition schemes. The detailed description is in the Section *6.1*.

STEP 3. Receivers


Receivers (geophones)

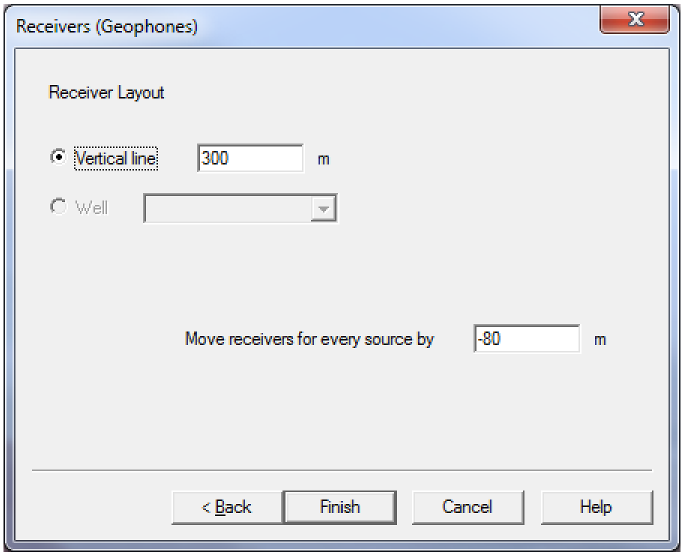
○ Numbrer & step
● Step & from & to
○ Number & step & from
○ All parameters
○ Number
○ Step

Number 15
Step 40 m
From 300 m
To 860 m

Specify 'From' as model top and 'To' as model bottom

In the dialogue box `Receivers (geophones)`, the receivers spread is specified for the first source.

STEP 4. Receivers (Additional parameters)


Receivers (Geophones)

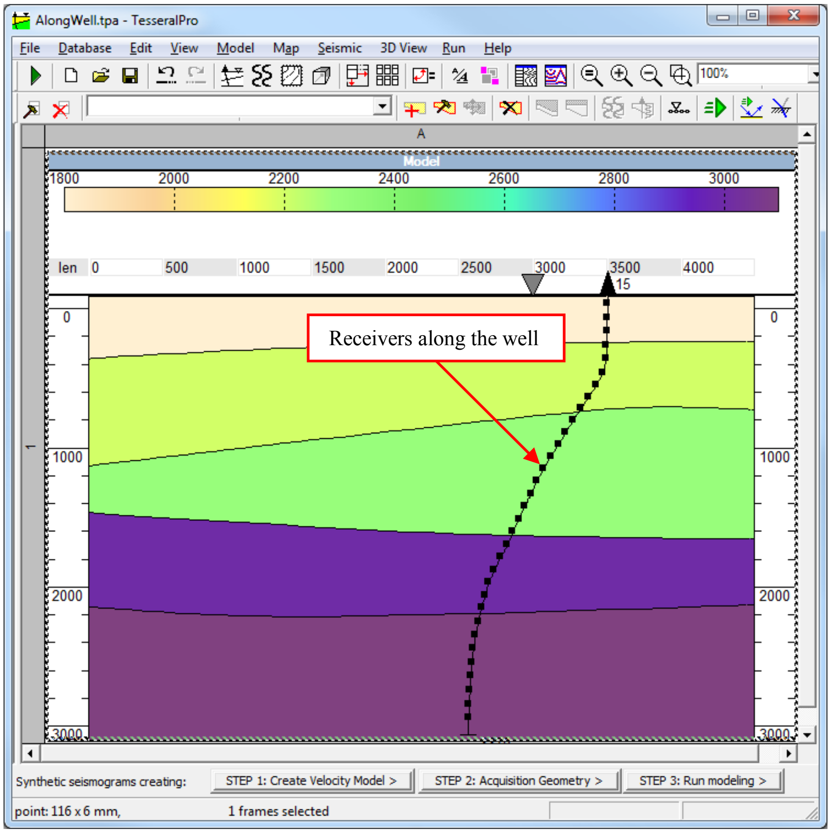
Receiver Layout

● Vertical line 300 m
○ Well

Move receivers for every source by -80 m

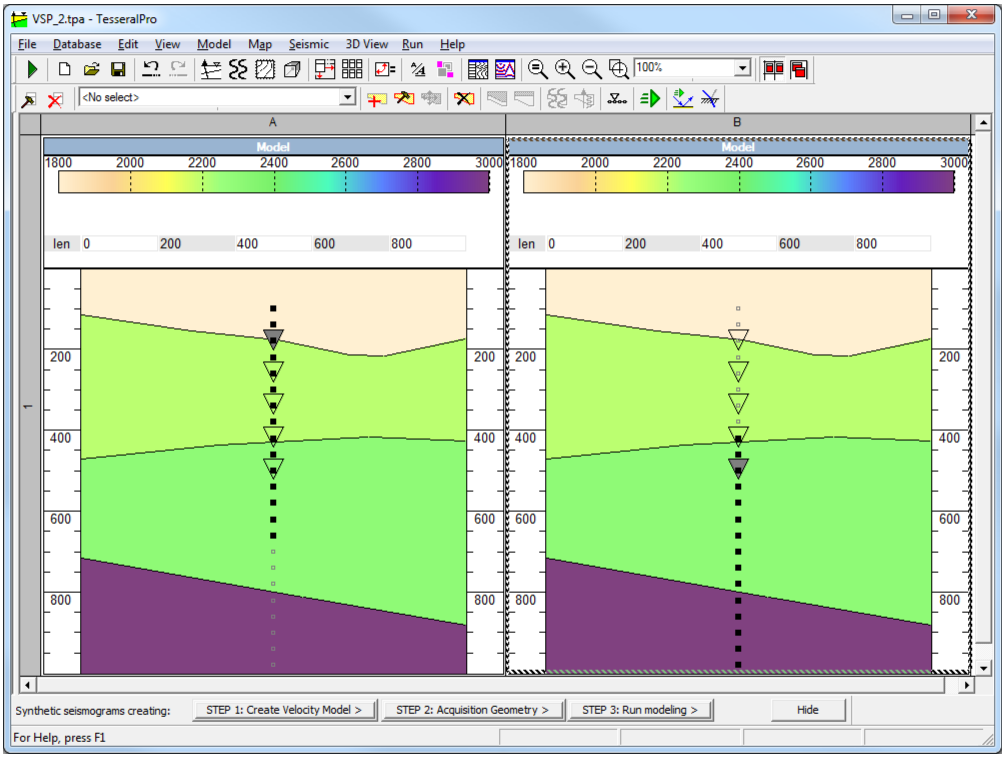
Specify the way receivers should be positioned: along the vertical line or along the well. The well may be selected from the list of wells, which are used in the model (in the Section *12.1*, it is described how to add a well into the model).

Below is an example of receiver spread along a well


AlongWell.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
Model
1800
2000
2200
2400
2600
2800
3000
len 0 500 1000 1500 2000 2500 3000 3500 4000
15
0
1000
2000
3000
Receivers along the well
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
point: 116 x 6 mm,
1 frames selected

6.5 *VSP dipole*

Both sources and receivers are located inside the well.


VSP_2.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
<No select>
A
B
Model
1800 2000 2200 2400 2600 2800 3000
len 0 200 400 600 800
200
400
600
800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

STEP 1. Acquisition scheme

In the dialogue box `Observation scheme` select `Dipole VSP`.

STEP 2. Sources – The dialogue box `Sources` is the same as other acquisition schemes. The only difference is that the sources are located along a vertical line or along the well.

STEP 3. Receivers – In the dialogue box `Receivers (geophones)`, like in the acquisition scheme *6.1*, the layout of receivers for the first source needs to be specified.

STEP 4. Receivers (Additional parameters)

Select one of the 2 options how the receivers are located: along a vertical line or along the well.

The parameter `Move receivers for every source by` is used for the acquisition scheme when the receivers are moving up along the well during the seismic observations.

6.6 Load acquisition geometry from gathers

If you have field gathers then the information on sources and receivers coordinates from the trace headers may be used to assign the acquisition scheme for a model.

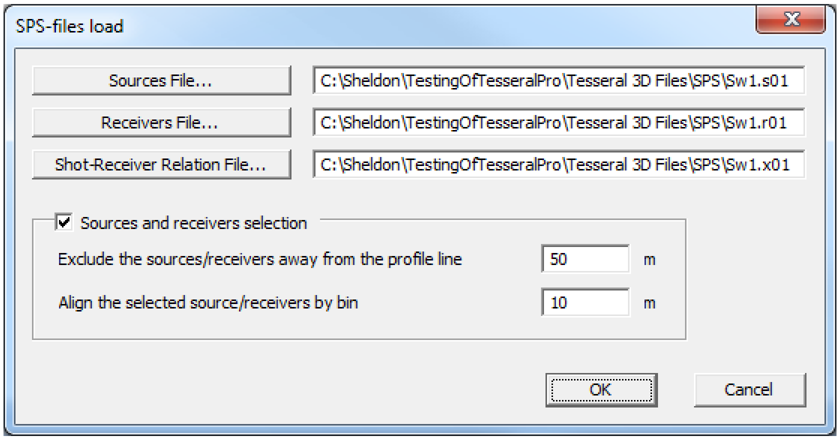
STEP 1. Acquisition scheme

In the `Observation scheme` dialogue box, select `Load from seismogram`. In the next standard `File open` dialogue box, select the seismic file. All the sources and receivers will be loaded from the trace's header of the selected gather.

6.7 Load acquisition scheme from SPS files

STEP 1. Acquisition scheme

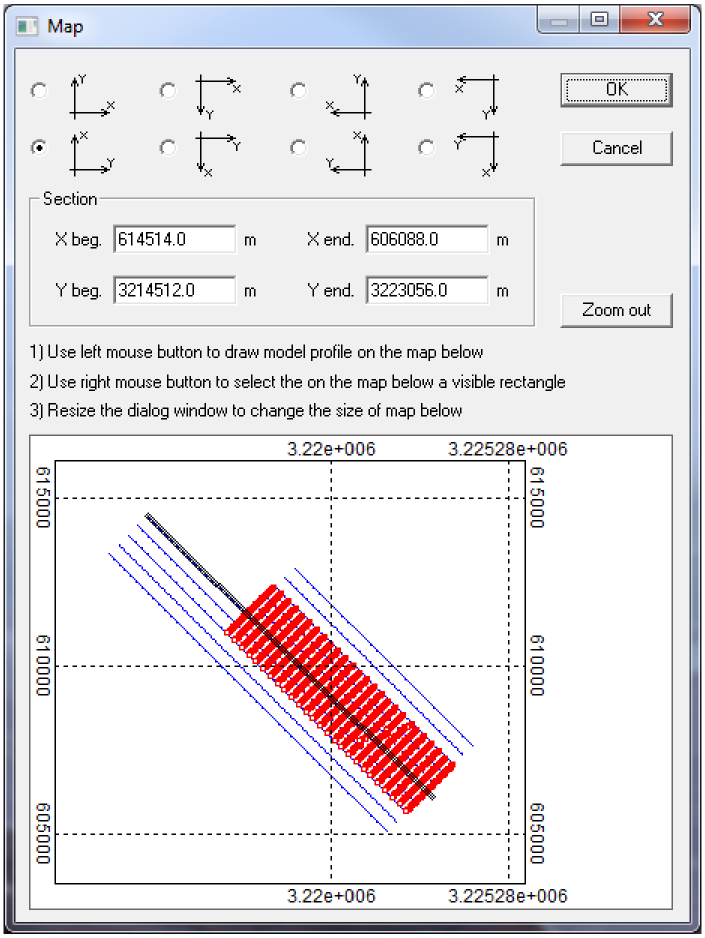
In the dialogue box `Observation scheme`, select `Load from SPS-file`. In the next dialogue box `SPS-files load`, select the SPS files. If you use the SPS file of a 3D spread, then in the group `Sources and receivers selection`, adjust the criteria for selecting sources and receivers to be loaded into the model and the binning size.



Sources File...: C:\Sheldon\TestingOfTesseralPro\Tesseral 3D Files\SPS\Sw1.s01
Receivers File...: C:\Sheldon\TestingOfTesseralPro\Tesseral 3D Files\SPS\Sw1.r01
Shot-Receiver Relation File...: C:\Sheldon\TestingOfTesseralPro\Tesseral 3D Files\SPS\Sw1.x01

☑ Sources and receivers selection
Exclude the sources/receivers away from the profile line: 50 m
Align the selected source/receivers by bin: 10 m

In the next dialogue box `Map`, select the model section along the receiver line.



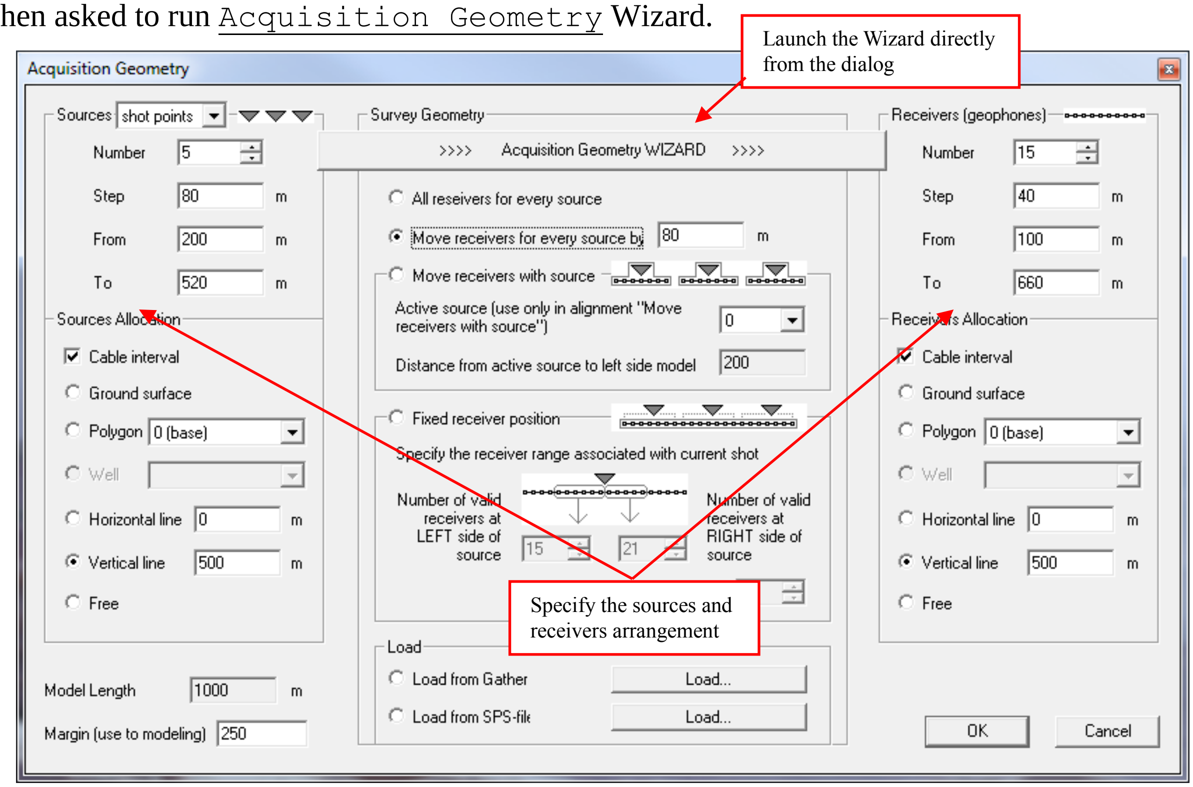
Section
X beg. 614514.0 m
X end. 606088.0 m
Y beg. 3214512.0 m
Y end. 3223056.0 m

1) Use left mouse button to draw model profile on the map below
2) Use right mouse button to select the on the map below a visible rectangle
3) Resize the dialog window to change the size of map below

If the model length is smaller than the length of the selected profile in the `Map` dialogue, you will be asked to correct (enlarge) the model. Tesseral Pro has the capability of creating a model using only SPS files (see Section *4.7* for more details).

6.8 Standard dialogue box for acquisition geometry

In addition to using Wizard for the sources and receivers layout, the integrated dialogue box can be used, which is activated by `Model > Acquisition Geometry`. Then select `No` when asked to run `Acquisition Geometry` Wizard.



Launch the Wizard directly from the dialog

Specify the sources and receivers arrangement

Sources: shot points
Number: 5
Step: 80 m
From: 200 m
To: 520 m

Sources Allocation
☑ Cable interval
○ Ground surface
○ Polygon: 0 (base)
○ Well
○ Horizontal line: 0 m
● Vertical line: 500 m
○ Free

Model Length: 1000 m
Margin (use to modeling): 250

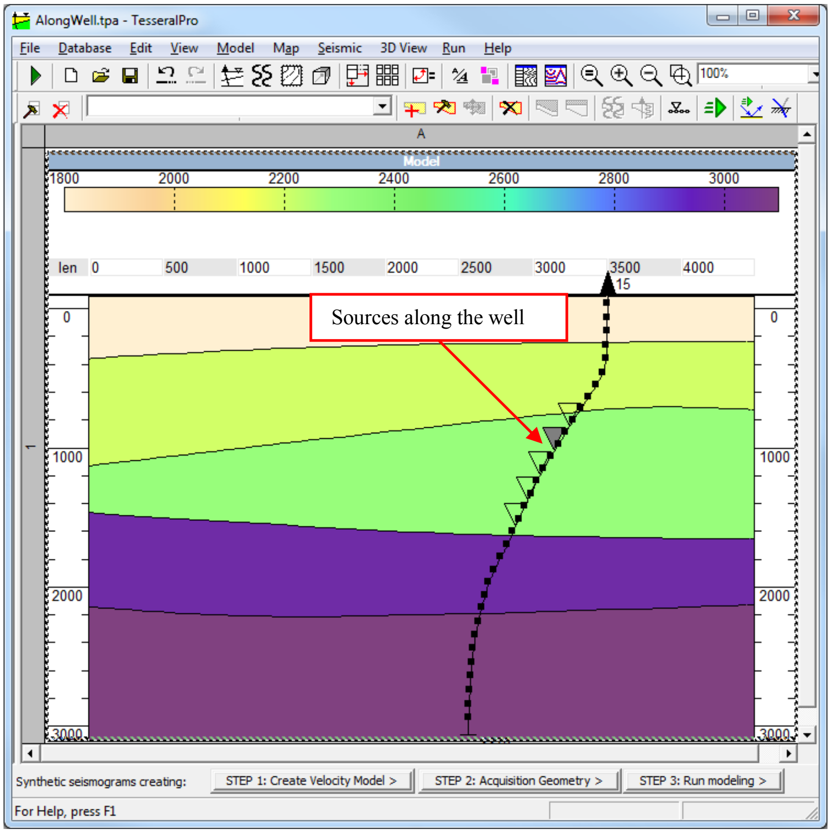
○ All receivers for every source
● Move receivers for every source by: 80 m
○ Move receivers with source
Active source (use only in alignment "Move receivers with source"): 0
Distance from active source to left side model: 200
○ Fixed receiver position
Specify the receiver range associated with current shot
Number of valid receivers at LEFT side of source: 15
Number of valid receivers at RIGHT side of source: 21

Load
○ Load from Gather
○ Load from SPS-file

Receivers (geophones)
Number: 15
Step: 40 m
From: 100 m
To: 660 m

Receivers Allocation
☑ Cable interval
○ Ground surface
○ Polygon: 0 (base)
○ Well
○ Horizontal line: 0 m
● Vertical line: 500 m
○ Free

The group `Sources` is for specifying the source layout, and the group `Receivers (geophones)` is to specify the receiver layout. The group of `Sources Allocation` or `Receivers Allocation` is to specify the line along which the sources or receivers will be positioned. If you select the option `Well` and a well from the list, then the sources (receivers) will be positioned along the selected well, as shown in the figure below.



AlongWell.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
Model
1800 2000 2200 2400 2600 2800 3000
len 0 500 1000 1500 2000 2500 3000 3500 4000
15
Sources along the well
0
1000
2000
3000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
For Help, press F1

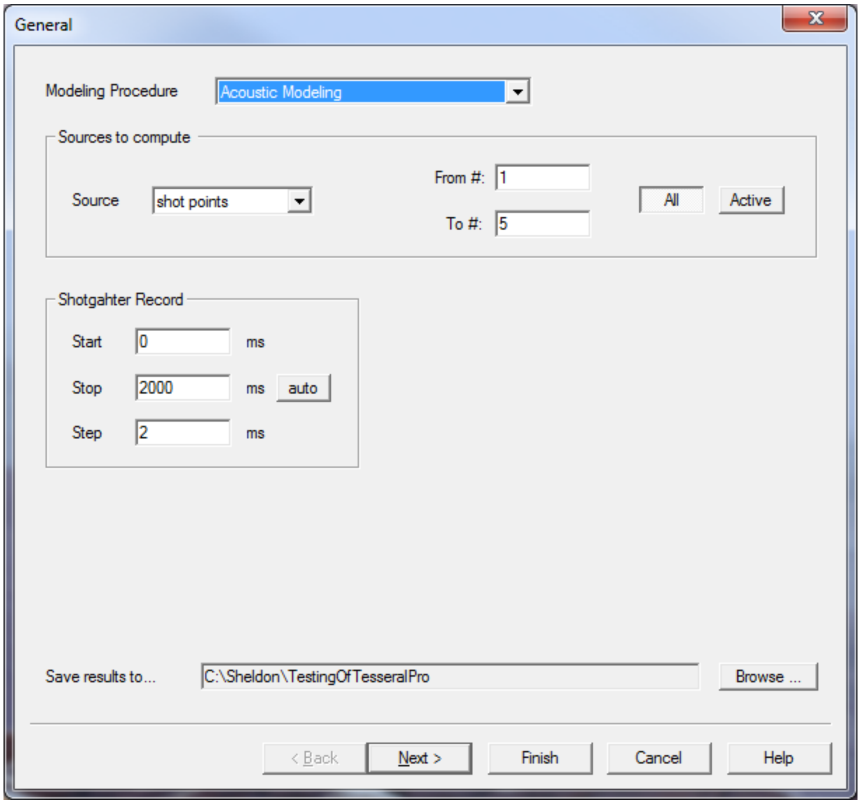
If you select the option Free in the group Sources Allocation or Receivers Allocation, then each source (receiver) can be positioned in the model independently from each other. For the other options, all sources and receivers will be positioned as a group along a specific line.

7 Synthetic gather calculation

Before launching the job of computing synthetic gather, a velocity model (Section *4*) and the corresponding acquisition geometry (Section *6*) needs to be designed firstly and then the project has to be saved by using the command `File > Save Project`.

Please use the menu command `Run > Run 2D Modeling` or `Run > Run 3D Modeling` to open the modeling parameter specification dialogue.

7.1 Modeling methods



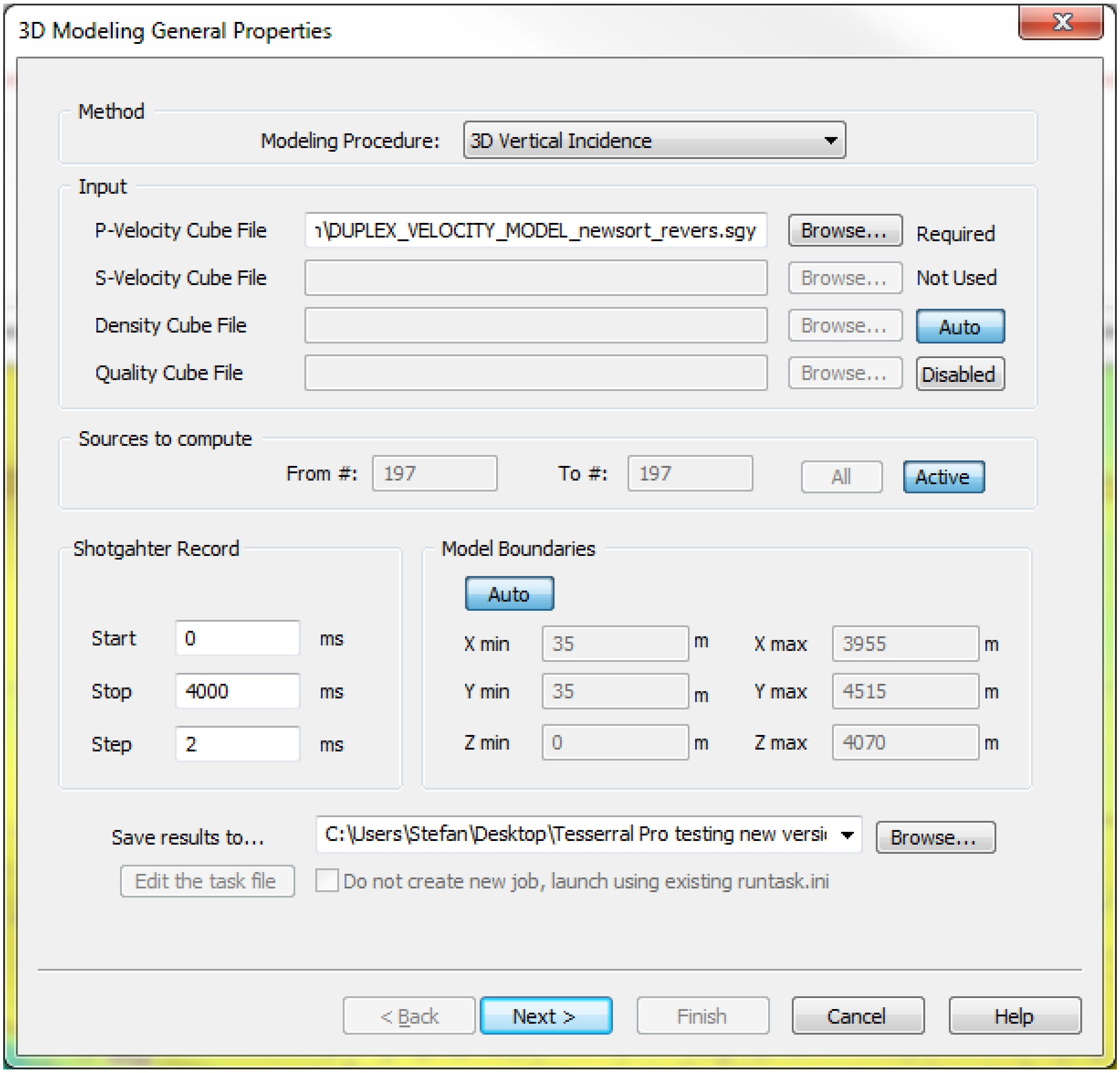
Modeling Procedure: Acoustic Modeling
Source: shot points
From #: 1
To #: 5
Start: 0 ms
Stop: 2000 ms
Step: 2 ms
Save results to...: C:\Sheldon\TestingOfTesseralPro

The `Modeling Procedure` parameter is for selecting the method used for solving the wave equation. The available modeling methods include:

- `2D Vertical Incidence` is to simulate the vertical propagation of waves for horizontal boundaries. It allows quick evaluation of the arrival time and the amplitudes of the reflected waves in the time section under the condition of strict 1D propagation of seismic energy.
- `2D Scalar` is for the scalar model of the medium (i.e., liquid approximation without considering variation of density). It only takes into account the variation of compressional velocity and it is the quickest method for the modeling of 2D wave propagation.
- `2D Acoustic` is for the acoustic model of the medium, which takes into account the variation of compressional velocity and density.
- `Acoustic without multiples` is for quickly obtaining the time section of the acoustic model of the medium. As a whole, it corresponds to the exploding interface mode of other methods, but it does not take into account the multiples and the image contains fewer noises. It enables users to intuitively understand the influence of multiples on the gather and seismic image by comparing with standard acoustic method.
- `2D Elastic` is for an isotropic elastic model. This is the main modeling method, which can simulate the 2D propagation of seismic energy in solid media by taking into account the effects of wave-mode conversion and the shear waves, as well as the effect of quasi-anisotropy caused by a stack of inter-bedded thin layers.
- `2D Elastic Anisotropic` is for a 2D-anisotropic elastic model and takes into account the variation of physical properties in horizontal and vertical direction. The input model can have up to 3 systems of 2D-oriented fracturing. This modeling method can

simulate the seismic energy propagation in anisotropic medium. The anisotropic parameters and/or fracturing parameters have to be specified by the user. If these parameters are not specified, the algorithm is equivalent to the isotropic elastic method.

- `2D Visco-Elastic` is for a visco-elastic model and can be used to evaluate the effects of seismic energy absorption. It also takes into account the velocity dispersion. The quality factor needs to be specified by the user. If this parameter is not specified, this algorithm is equivalent to Elastic Modeling. This modeling method allows users to examine the influence of fluid on wave propagation.
- `2D Eikonal Ray Tracing` is the ray-tracing method for isotropic and anisotropic medium and is based on the high-frequency (optical) approximation of wave-equation modeling. It does not calculate the multiples but may take into account converted waves at the reflector. The method is not suitable for a thin-layered model. This method enables users to evaluate horizons' illumination taking into account reflection waves. (Other methods can only show incident wave energy instead of the illumination).
- `2.5D Elastic/Elastic Anisotropic + Visco-Elastic*` is for 3D isotropic or anisotropic elastic model with arbitrarily-oriented fracturing sets in 3D space. It is assumed that the variation of the rock properties goes along the model's profile, while the variation perpendicular to the model's plane (along the Y axis) is negligible. This method can generate not only 2D/3C gathers but also 3D/3C ones, and in case of a vector source even 3D/9C gathers can be generated. The parameters of anisotropy and fracturing have to be specified. The azimuth is relative to the profile line of the model. Additionally modeling of frequency dependent attenuation (Visco-Elastic) is also an option. `2D 3D`
- `3D Vertical Incidence` is to simulate the vertical propagation of waves for horizontal boundaries. It allows quick evaluation of the arrival time and the amplitudes of the reflected waves in the time section under the condition of strict 1D propagation of seismic energy. To access this method this method please first create a 3D observation system (See ***9.1***) then `Run> Run 3D modeling`


3D Modeling General Properties

Method

Modeling Procedure: 3D Vertical Incidence

Input

P-Velocity Cube File: ı\DUPLEX_VELOCITY_MODEL_newsort_revers.sgy — Required

S-Velocity Cube File — Not Used

Density Cube File — Auto

Quality Cube File — Disabled

Sources to compute

From #: 197 To #: 197

Shotgahter Record

Start 0 ms

Stop 4000 ms

Step 2 ms

Model Boundaries

X min 35 m X max 3955 m

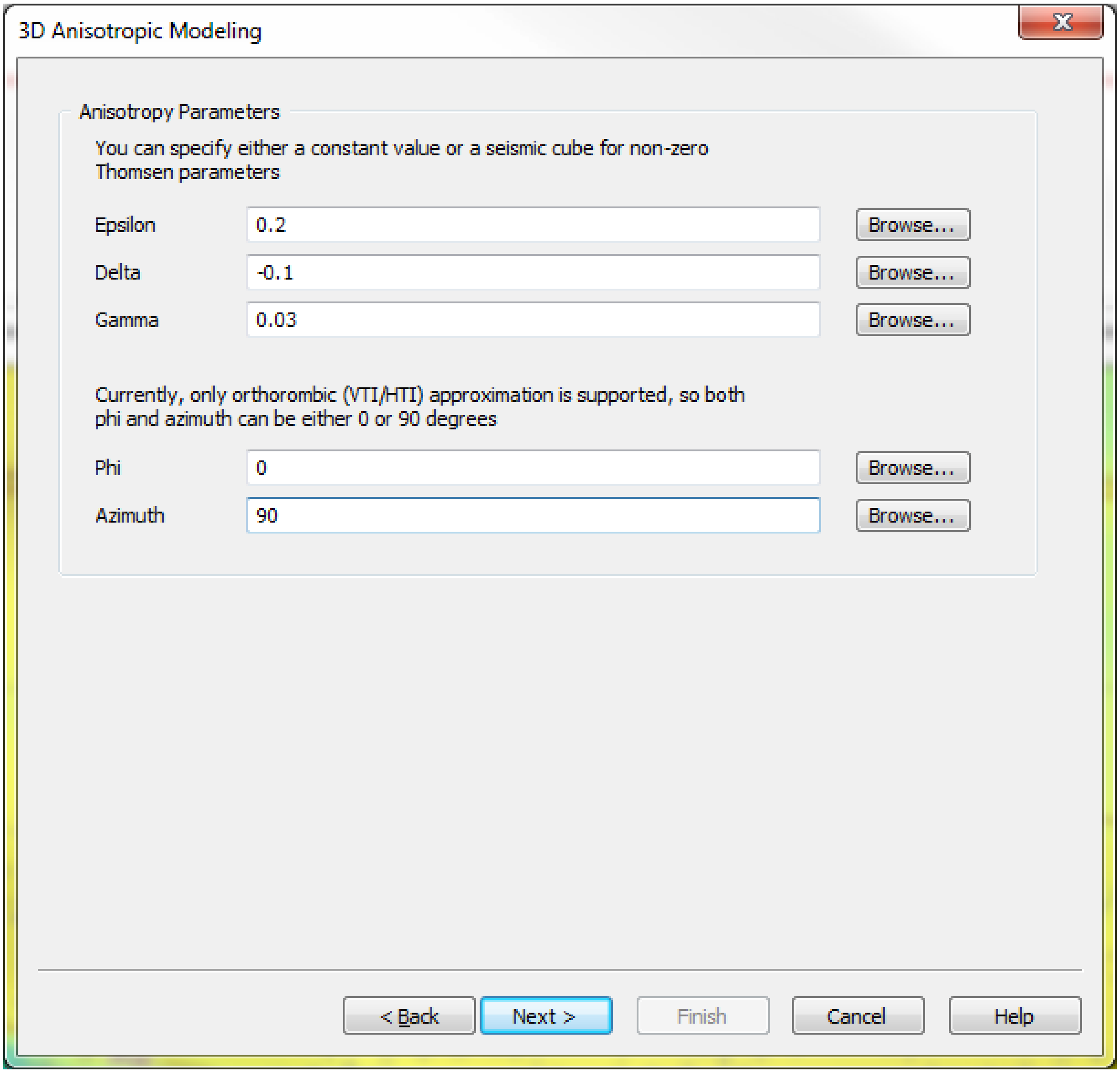
Y min 35 m Y max 4515 m

Z min 0 m Z max 4070 m

Save results to… C:\Users\Stefan\Desktop\Tesserral Pro testing new versi

☐ Do not create new job, launch using existing runtask.ini

- `3D-3C Acoustic, Elastic*` allows approximating wave propagation in conditions
  of realistically heterogeneous (in all 3 directions X,Y and Z) medium. This modelling can be applied to the objects like reefs, salt domes, different kinds of collapse/breakthrough
  chimneys or steeply inclined faults etc. in the areas where an accurate 3D reservoir characterization is required.
  Note*: 2.5-3D-3C Full-wave (finite-difference) modelling, due to its computational intensity, is based on *Parallel Options* including *multi-core, -node, -GPU* solutions allowing to run such simulations in a feasible turnaround time.
  To access this method this method please first create a 3D observation system (See ***9.1***) then `Run> Run 3D modeling`.
- `3D-3C elastic method for VTI/HTI mediums`. Fort this method the anisotropic parameters of the medium need to be specified. Either constant values or seismic cubes for the anisotropic parameters need to be uploaded in the `3D Anisotropic Modeling` window.


3D Anisotropic Modeling
Anisotropy Parameters
Browse...
Browse...
Browse...
Browse...
Browse...
< Back
Next >
Finish
Cancel
Help

You can specify either a constant value or a seismic cube for non-zero Thomsen parameters

Epsilon: 0.2

Delta: -0.1

Gamma: 0.03

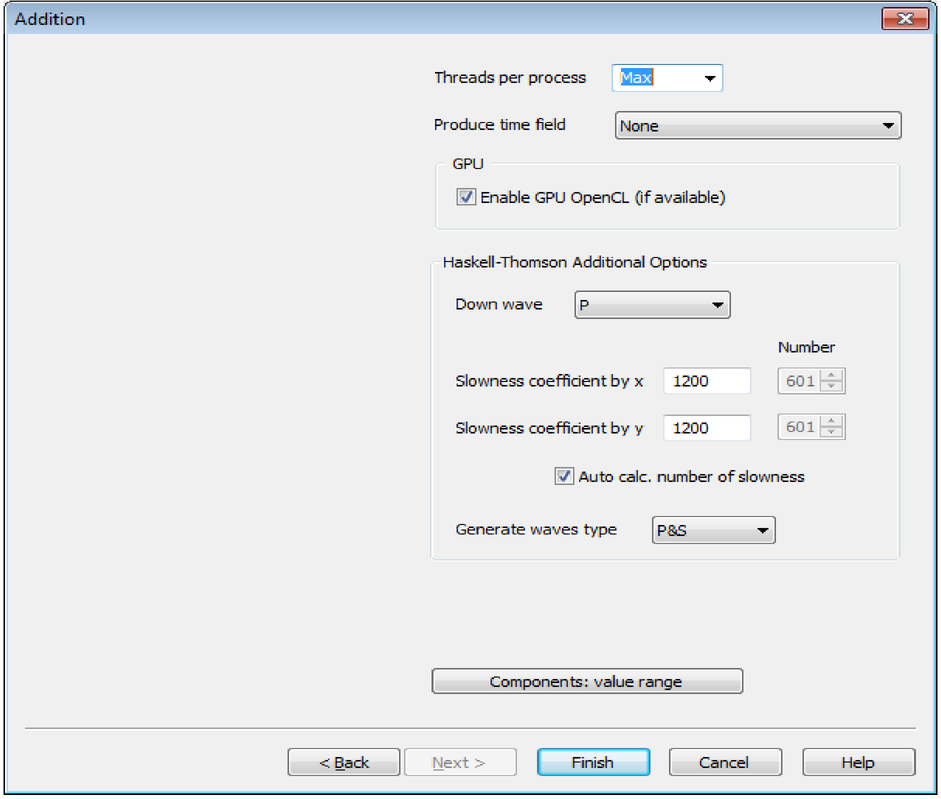
Currently, only orthorombic (VTI/HTI) approximation is supported, so both phi and azimuth can be either 0 or 90 degrees

Phi: 0

Azimuth: 90

To access this method please, create a 3D observation system first (see ***9.1***), then `Run> Run 3D modeling`.

- `Haskell-Thomson` is a 2D/3D modelling method that is strictly designed for VTI mediums. It implements spectral decomposition along X, Y and also time and as a result the wave field propagates in 1D along the Z axis. The method essentially allows the user to generate partial wave fields by allowing the user to choose the type of propagating (i.e. `Down Wave`) and receiving (i.e. `Generate wave type`) waves, while allowing full wave mode conversion in inter-bedded layers.

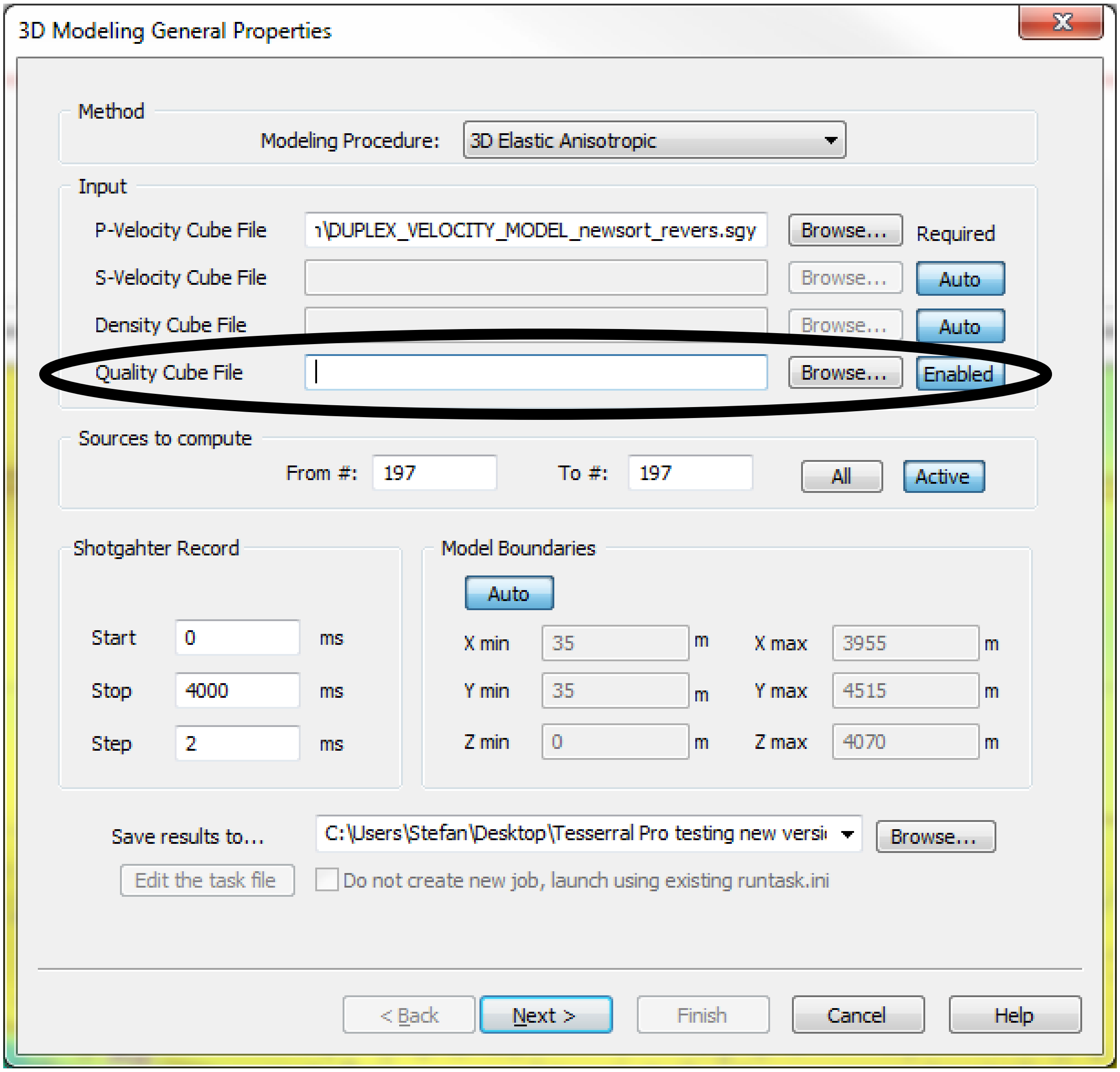
  Threads per process: Max
  Produce time field: None
  GPU
  ☑ Enable GPU OpenCL (if available)
  Haskell-Thomson Additional Options
  Down wave: P

		Number
Slowness coefficient by x	1200	601
Slowness coefficient by y	1200	601

  ☑ Auto calc. number of slowness
  Generate waves type: P&S

  The `Slowness Coefficient by x` and `Slowness Coefficient by y` (1200 in this case), implies that the range of slowness is limited by 1200/Vs where Vs is the minimum shear wave velocity in the model. The `Number` parameter determines the number of used harmonics, (i.e. slowness).With these two variables all possible reflected and surface waves can be modeled, provided that a large `Number` of slowness is used (i.e. 601). A smaller number of slowness would result in modeling of reflected waves only, while supressing the surface ones(e.g. Rayleigh Waves).

- `3D-3C visco elastic method` is used to evaluate the effects of seismic energy absorption in a 3D medium with or without any VTI/HTI anisotropy. For this method the `Quality Cube file` (i.e. Q factor cube) needs to be loaded in the `3D Modeling General Properties` tab for the `3D Elastic` or `3D Elastic Anisotropic` modelling procedure.


3D Modeling General Properties
Method
Input
Browse...
Required
Browse...
Auto
Browse...
Auto
Browse...
Enabled
Sources to compute
All
Active
Shotgahter Record
Model Boundaries
Auto
Browse...
Edit the task file
< Back
Next >
Finish
Cancel
Help

Modeling Procedure: 3D Elastic Anisotropic

P-Velocity Cube File: ı\DUPLEX_VELOCITY_MODEL_newsort_revers.sgy

S-Velocity Cube File:

Density Cube File:

Quality Cube File:

From #: 197

To #: 197

Start: 0 ms

Stop: 4000 ms

Step: 2 ms

X min: 35 m

X max: 3955 m

Y min: 35 m

Y max: 4515 m

Z min: 0 m

Z max: 4070 m

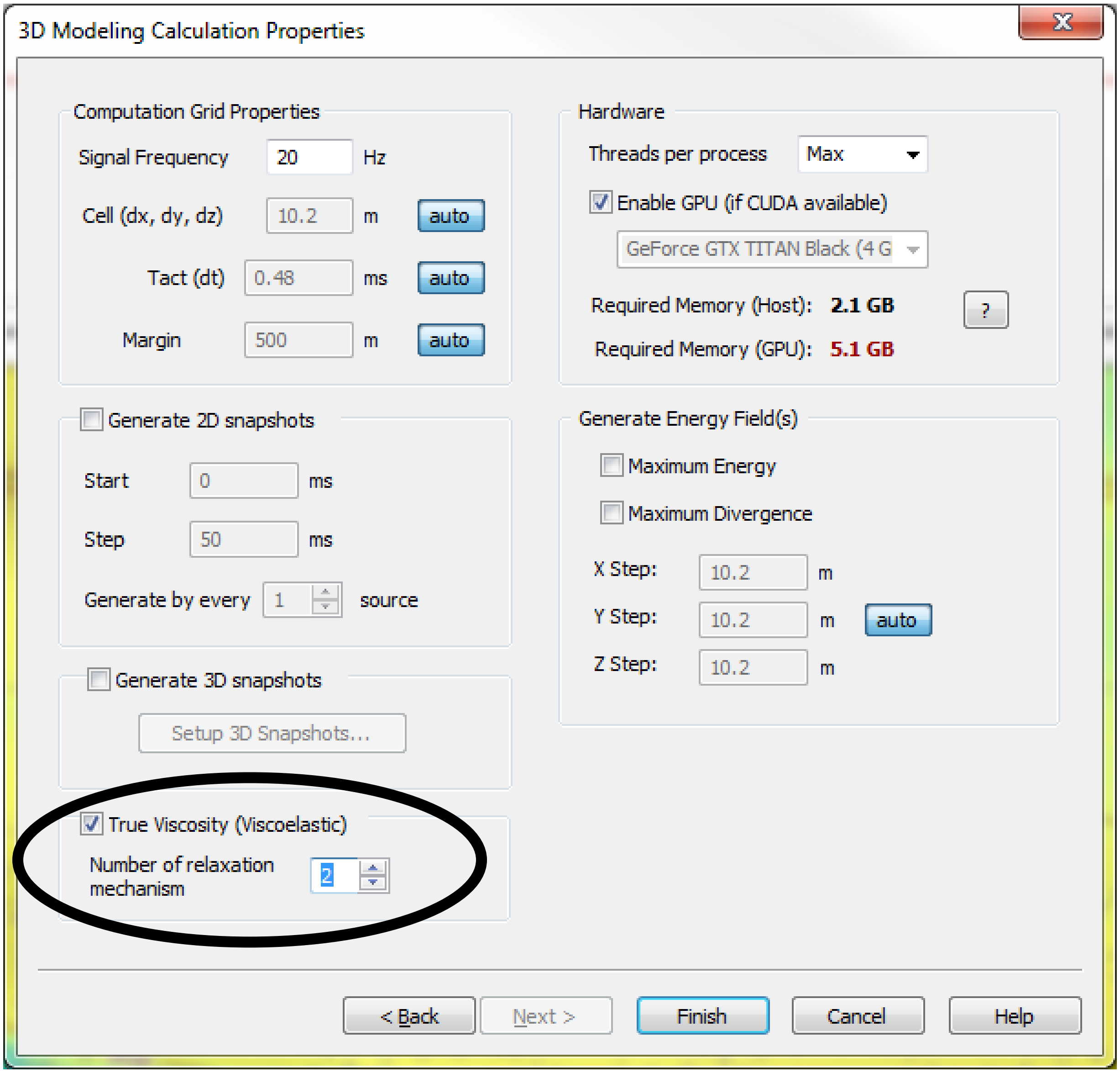
Save results to...: C:\Users\Stefan\Desktop\Tesserral Pro testing new versi

☐ Do not create new job, launch using existing runtask.ini

To access this method this method please first create a 3D observation system (See ***9.1.6***) then access `Run> Run 3D modeling`.

Also, in order for velocity dispersion (i.e. frequency dependency) to be taken into account, the

`Number of relaxation mechanisms` must be specified in the `3D Modeling Calculation Properties`. This 3D viscoelastic method allows users to examine the effect of fluid on full 3D wave propagation



3D Modeling Calculation Properties

Computation Grid Properties

Signal Frequency 20 Hz

Cell (dx, dy, dz) 10.2 m

Tact (dt) 0.48 ms

Margin 500 m

☐ Generate 2D snapshots

Start 0 ms

Step 50 ms

Generate by every 1 source

☐ Generate 3D snapshots

Setup 3D Snapshots...

☑ True Viscosity (Viscoelastic)

Number of relaxation mechanism 2

Hardware

Threads per process Max

☑ Enable GPU (if CUDA available)

GeForce GTX TITAN Black (4 G

Required Memory (Host): **2.1 GB**

Required Memory (GPU): **5.1 GB**

Generate Energy Field(s)

☐ Maximum Energy

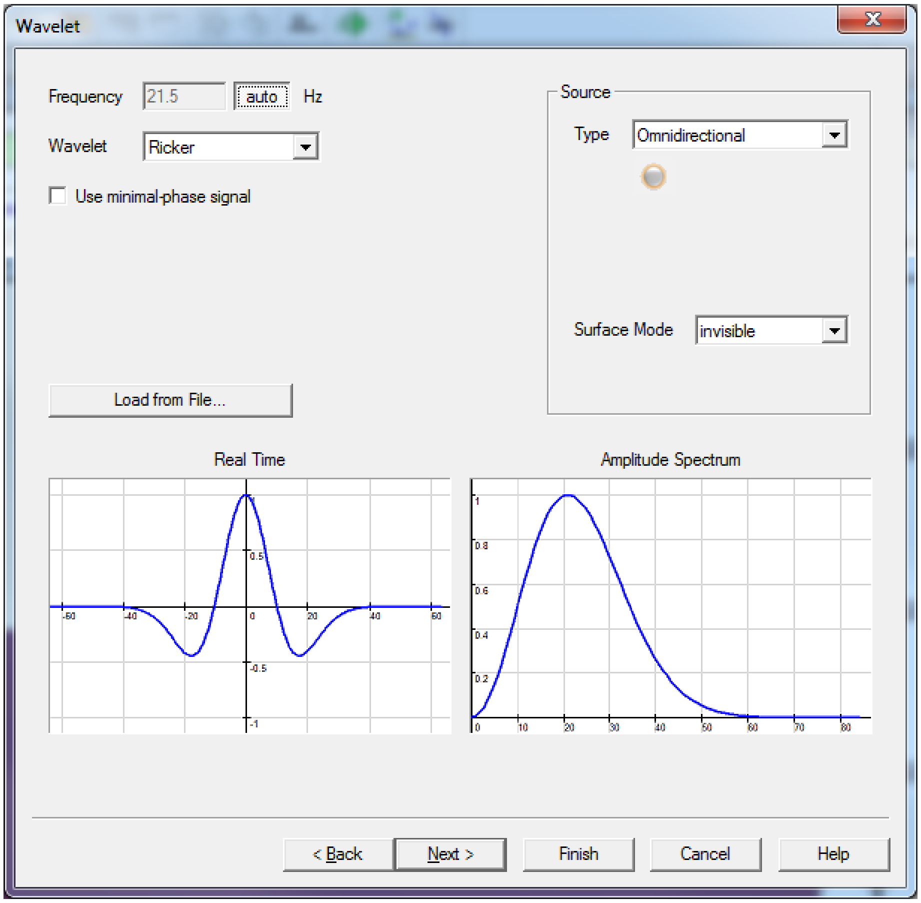
☐ Maximum Divergence

X Step: 10.2 m

Y Step: 10.2 m

Z Step: 10.2 m

7.2 Source wavelet



Frequency 21.5 Hz

Wavelet Ricker

☐ Use minimal-phase signal

Type Omnidirectional

Surface Mode invisible

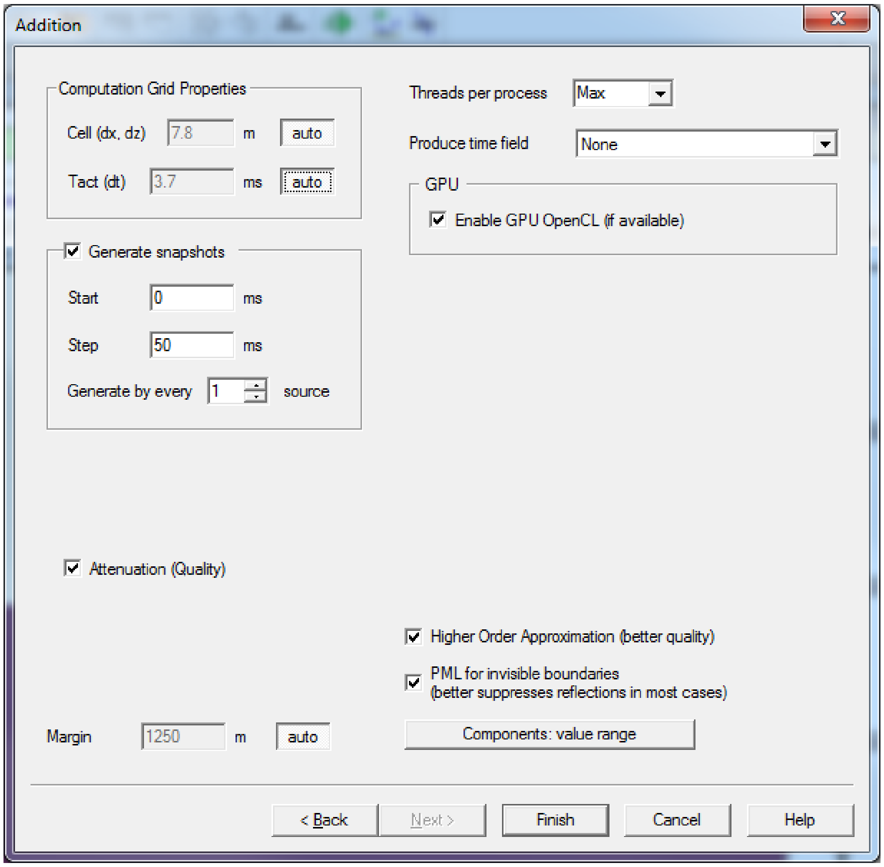
Select the dominant frequency of the source signal by the parameter `Frequency`. This parameter has considerable influence on quality of computed gathers and on time step needed for stable wave continuation. Generally, the higher the frequency, the longer the computation time.

- Parameter `Wavelet` is used for the selection of the signal's form. In addition to these standard wavelet types, you may load any kind of signal from a text file by pressing the button `Load from File`.
- Parameter `Source Mode` is used to specify the signal's directionality.
- Parameter `Surface Mode` – If `invisible` is selected, the free-surface related reflection will not appear in the seismic wave field. If `free` is selected, the free-surface related reflection is taken into account in the wavefield.
- The option `Use minimal-phase signal` – If the option is checked, the amplitude spectrum of the signal will be kept unchanged, but its phase spectrum will be changed to obtain the minimum-phase signal.
- The option `Suppress Source SV` is for suppressing shear waves. When the source is located closely to the free surface, checking this option can reduce strong surface waves in the shot gather, when Elastic Modeling or Elastic Anisotropic Modeling is used.
-

7.3 Additional parameters

Some specific parameters associated with various modeling procedures are to be specified. Therefore, the available parameters in the dialogue box `Addition` differ depending on the selected modeling procedure in the previous step (see Section *7.1*).

For the finite difference solution of the wave equation, e.g., Vertical Incidence Modeling, Scalar Modeling, Acoustic Modeling, Elastic Modeling and Elastic Anisotropic Modeling, the dialogue box `Addition` consists of the following parameters:



Addition

Computation Grid Properties
Cell (dx, dz) 7.8 m auto
Tact (dt) 3.7 ms auto

☑ Generate snapshots
Start 0 ms
Step 50 ms
Generate by every 1 source

☑ Attenuation (Quality)

Margin 1250 m auto

Threads per process Max
Produce time field None

GPU
☑ Enable GPU OpenCL (if available)

☑ Higher Order Approximation (better quality)
☑ PML for invisible boundaries (better suppresses reflections in most cases)

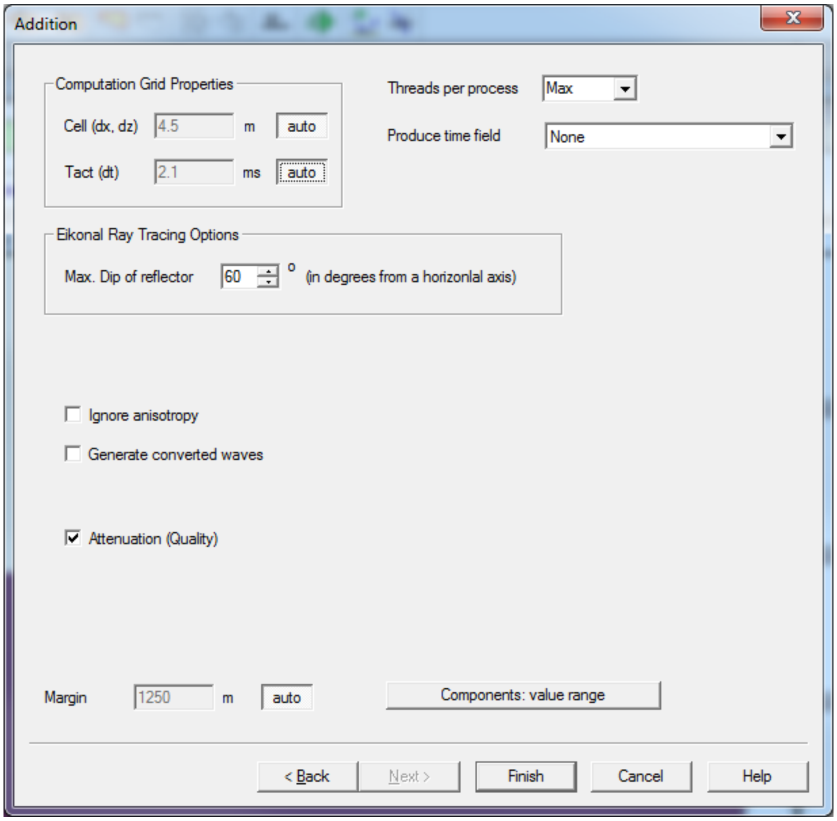
- `Computation Grid Properties` are the parameters of the grid size and time step for finite-difference modeling. It is recommended to use default values by having the buttons `auto` pressed down)
- `Generate snapshots` – during numerical modeling, a special file `Snap.tgr` is created, which contains the snapshots of the wavefield. The parameter `Start` is the time when generation of snapshots starts. The parameter `Step` (step of discretization) is the time interval between two successive snapshots.
- `Generate by every … source` to specify the source interval with which the snapshot is generated.

NOTE: The snapshots file (…Snap.tgr) for each source uses lots of computer memory. Additionally, merging of the snapshots for each source into one single file (this is the last phase of synthetic gather computation) requires significant time. Thus, it is recommended not to generate snapshots if you do not need them or specify larger time interval for generation of snapshots (parameter `Step`) and omit some sources by parameter `Generate by every … source`.

- The option `Use attenuation` determines whether to take into account the Quality factor during computation if it was specified for a polygon (please see details in the Section ***5.6***)
- `Margin` is for widening the computation area outside the acquisition aperture.
- `Threads per process` – Determines the number of cores used during modeling. `Max` means that all the processor cores are used.
- `Produce time field` – During the computation of the wavefield, the time field of the incident waves can be generated: `First Arrivals` for the first arrivals of the incident wave and `Maximum Energy` for the arrival of the most-energetic incident wave.
- `Components: value range` – When the model is built by well database (please see details in the Section ***5.10***), the parameters limit the values of velocity and density of the polygons which are obtained from the well logging data by interpolation.

7.3.1 Eikonal Ray Tracing Modeling

For eikonal ray tracing modeling method, the parameter `Max. Dip of reflector` is added, which limits the slope angle of the reflector. The feature of `Snapshot` is not supported in case of eikonal ray tracing.



Addition

Computation Grid Properties

Cell (dx, dz) 4.5 m auto

Tact (dt) 2.1 ms auto

Threads per process Max

Produce time field None

Eikonal Ray Tracing Options

Max. Dip of reflector 60 ° (in degrees from a horizonlal axis)

☐ Ignore anisotropy

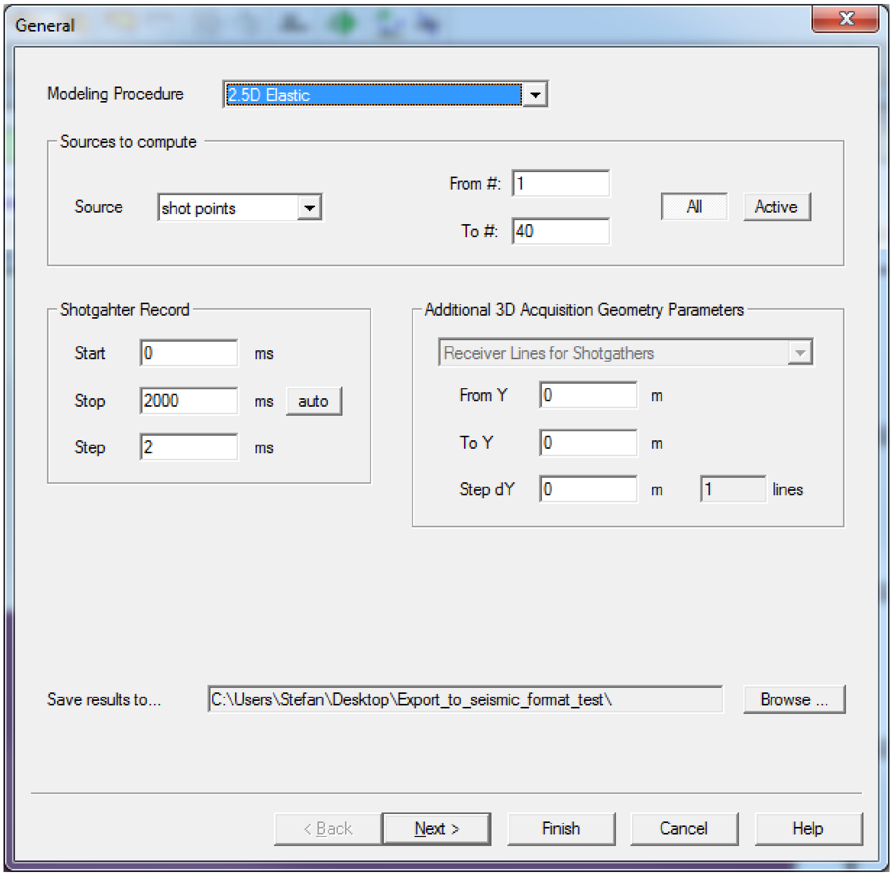
☐ Generate converted waves

☑ Attenuation (Quality)

Margin 1250 m auto

7.3.2 2.5D Elastic Anisotropic Modeling

For 2.5D modeling, the `Receiver Lines for Shotgathers` group is added in the first `General` dialogue box, which allows specifying the range and interval of the receiver line in the direction of the crossing line.


General
Sources to compute
All
Active
Shotgahter Record
auto
Additional 3D Acquisition Geometry Parameters
Browse ...
< Back
Next >
Finish
Cancel
Help

Modeling Procedure: 2.5D Elastic

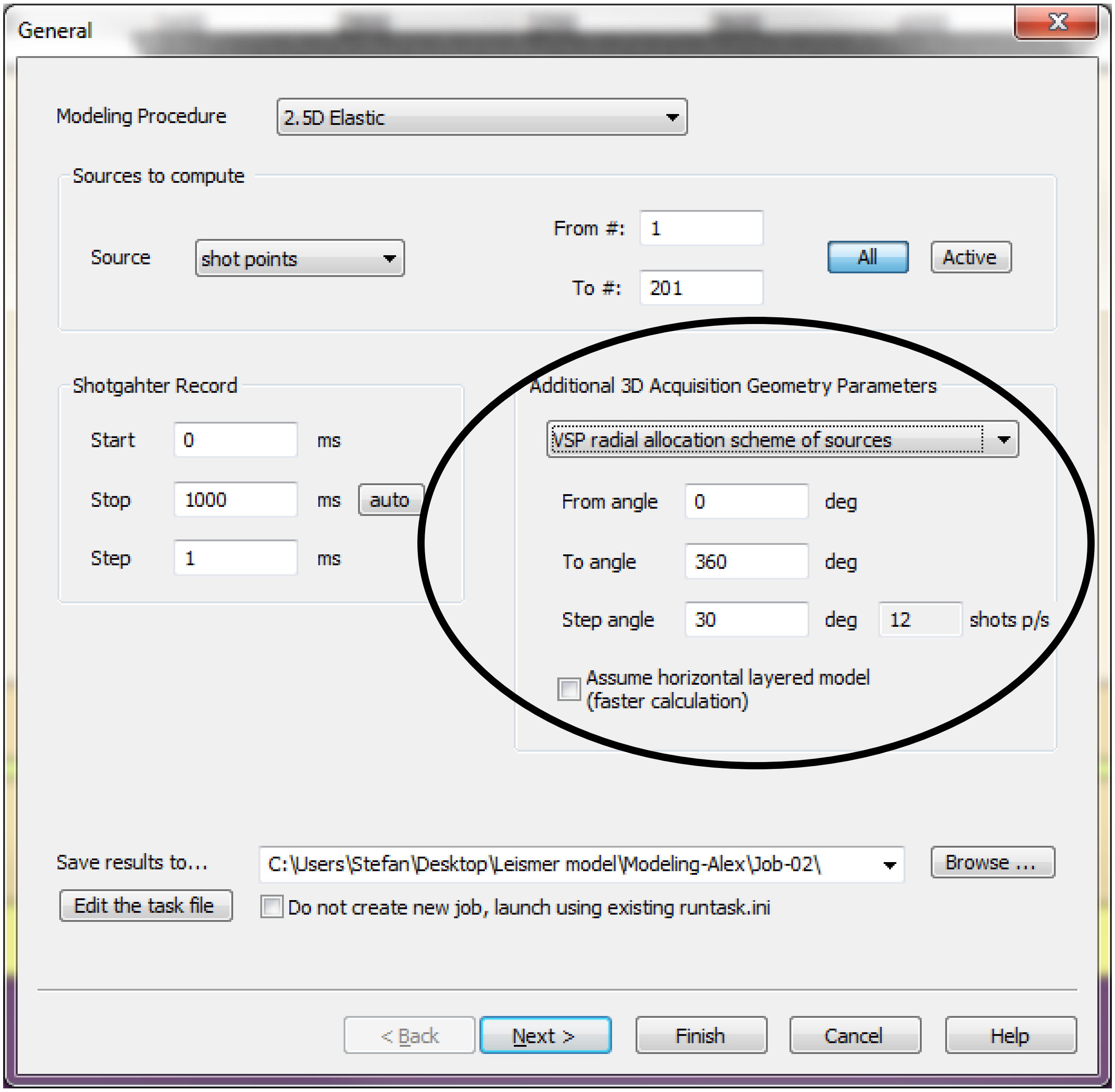
Source: shot points
From #: 1
To #: 40

Start: 0 ms
Stop: 2000 ms
Step: 2 ms

Receiver Lines for Shotgathers
From Y: 0 m
To Y: 0 m
Step dY: 0 m 1 lines

Save results to ... C:\Users\Stefan\Desktop\Export_to_seismic_format_test\

If a 2D VSP acquisition geometry was built, then the user can replicate it to a circular VSP survey by selecting `VSP radial allocation scheme of sources`.



General

Modeling Procedure: 2.5D Elastic

Sources to compute

Source: shot points

From #: 1

To #: 201

Shotgahter Record

Start: 0 ms

Stop: 1000 ms

Step: 1 ms

Additional 3D Acquisition Geometry Parameters

VSP radial allocation scheme of sources

From angle: 0 deg

To angle: 360 deg

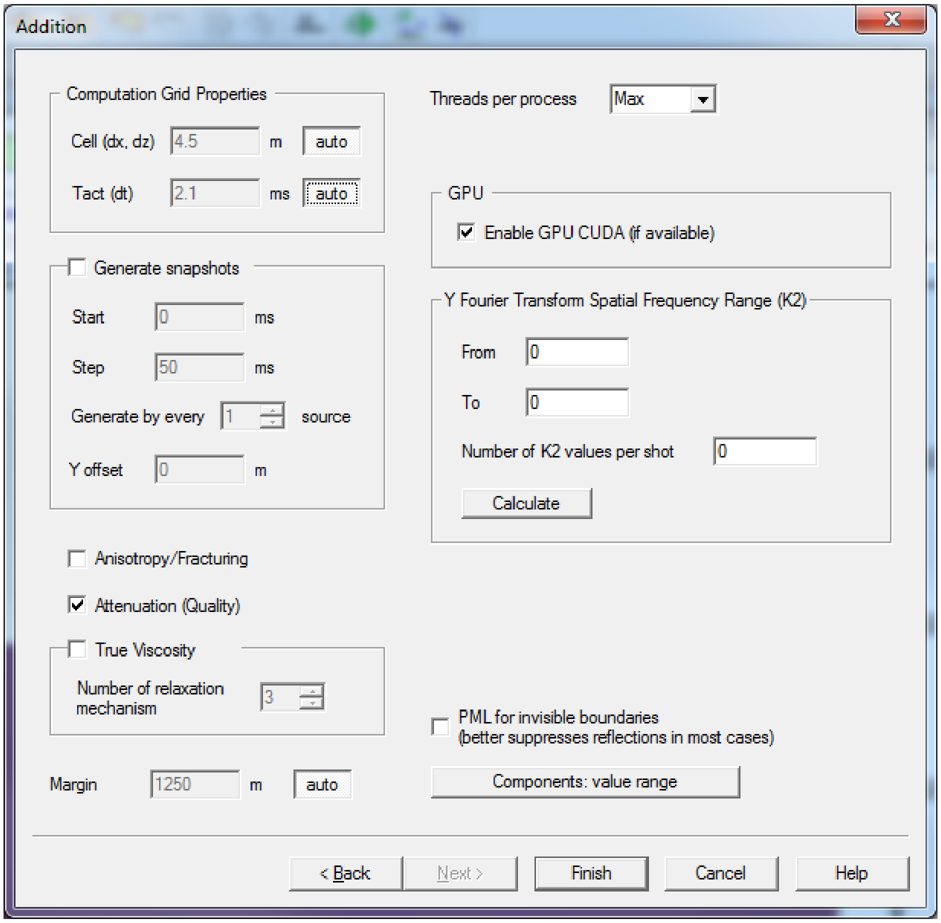
Step angle: 30 deg, 12 shots p/s

☐ Assume horizontal layered model (faster calculation)

Save results to...: C:\Users\Stefan\Desktop\Leismer model\Modeling-Alex\Job-02\

☐ Do not create new job, launch using existing runtask.ini

In the dialogue box `Addition`, the group `Y Fourier Transform Spatial Frequency Range (K2)` is added. It is specific for implementation of 2.5D modeling which use the spectral decomposition technique in the Y direction where variation of the rock parameters is assumed to be invariant.



Addition

Computation Grid Properties

Cell (dx, dz) 4.5 m auto

Tact (dt) 2.1 ms auto

☐ Generate snapshots

Start 0 ms

Step 50 ms

Generate by every 1 source

Y offset 0 m

☐ Anisotropy/Fracturing

☑ Attenuation (Quality)

☐ True Viscosity

Number of relaxation mechanism 3

Margin 1250 m auto

Threads per process Max

GPU

☑ Enable GPU CUDA (if available)

Y Fourier Transform Spatial Frequency Range (K2)

From 0

To 0

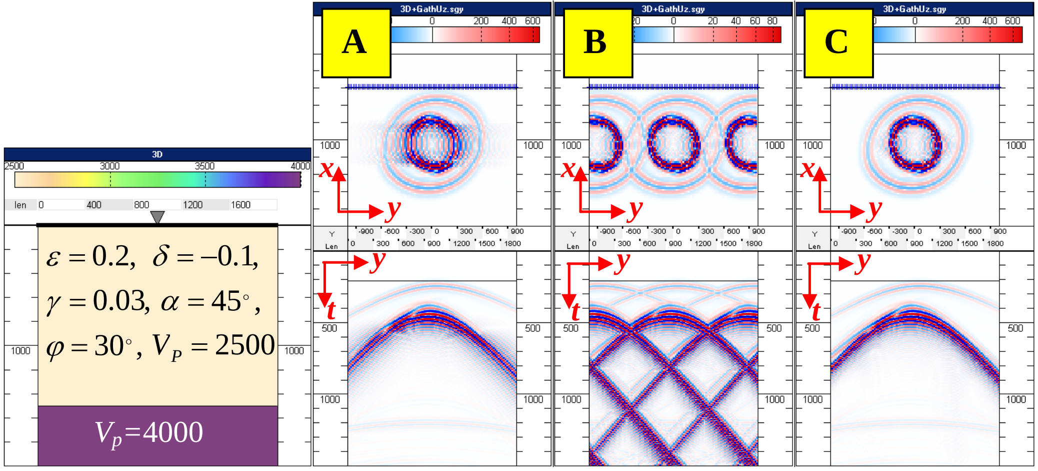
Number of K2 values per shot 0

☐ PML for invisible boundaries (better suppresses reflections in most cases)

The gathers in the ‘A’ column are noisy due to insufficient range of spatial frequency (`From`, `To`).

The gathers in the ‘B’ column contain the signal from virtual sources due to insufficient number of spatial frequencies (`Number of K2 values per shot`).

The gathers in the ‘C’ column are correct.

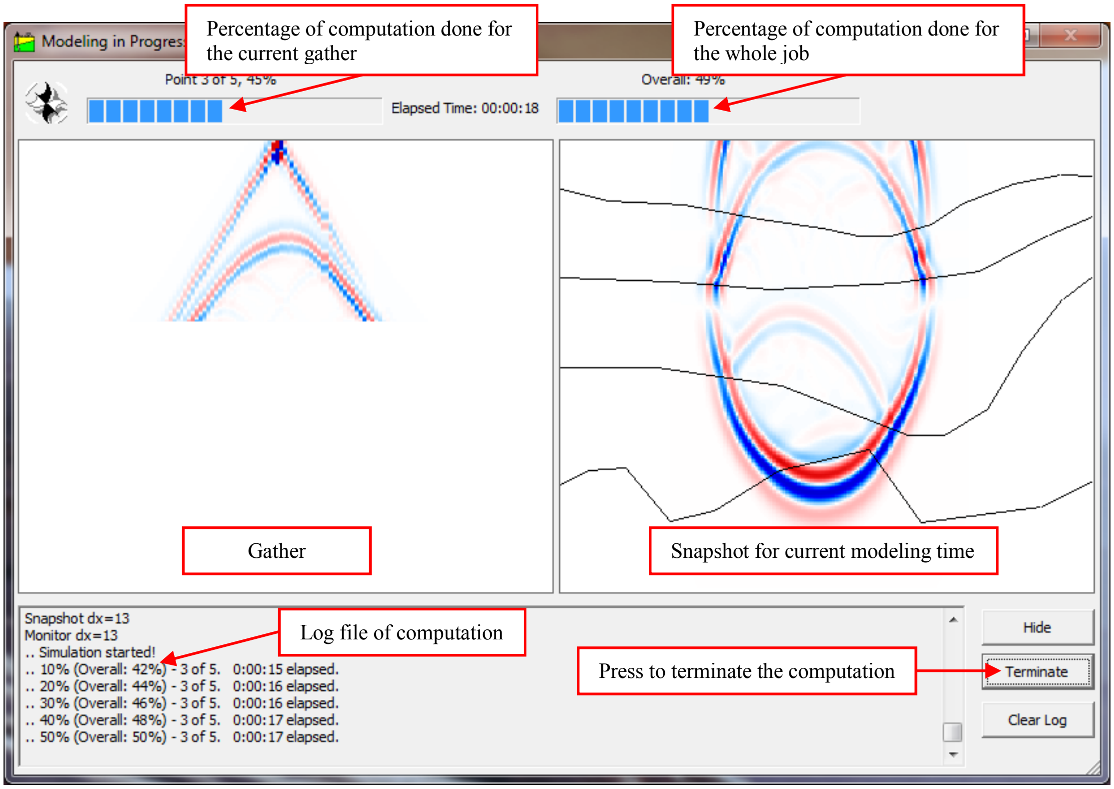


It is recommended to adjust these spectral decomposition parameters automatically by pressing the button `Calculate` in the lower part of the same group.

In any case, the 2.5D modeling requires huge amount of computations, just like a complete 3D case. It is accelerated by effective parallelization, especially by using GPU (NVIDIA CUDA). To decrease the computation time, users can specify shorter time for the parameter `Stop` in the dialogue box `General`.

7.4 Gather Calculation

After the modeling method and the relevant parameters are specified, please press the button `finish` to launch the job and then the `Modeling in Progress` window should appear to allow users to monitor the job progress.



Percentage of computation done for the current gather

Percentage of computation done for the whole job

Gather

Snapshot for current modeling time

Log file of computation

Press to terminate the computation

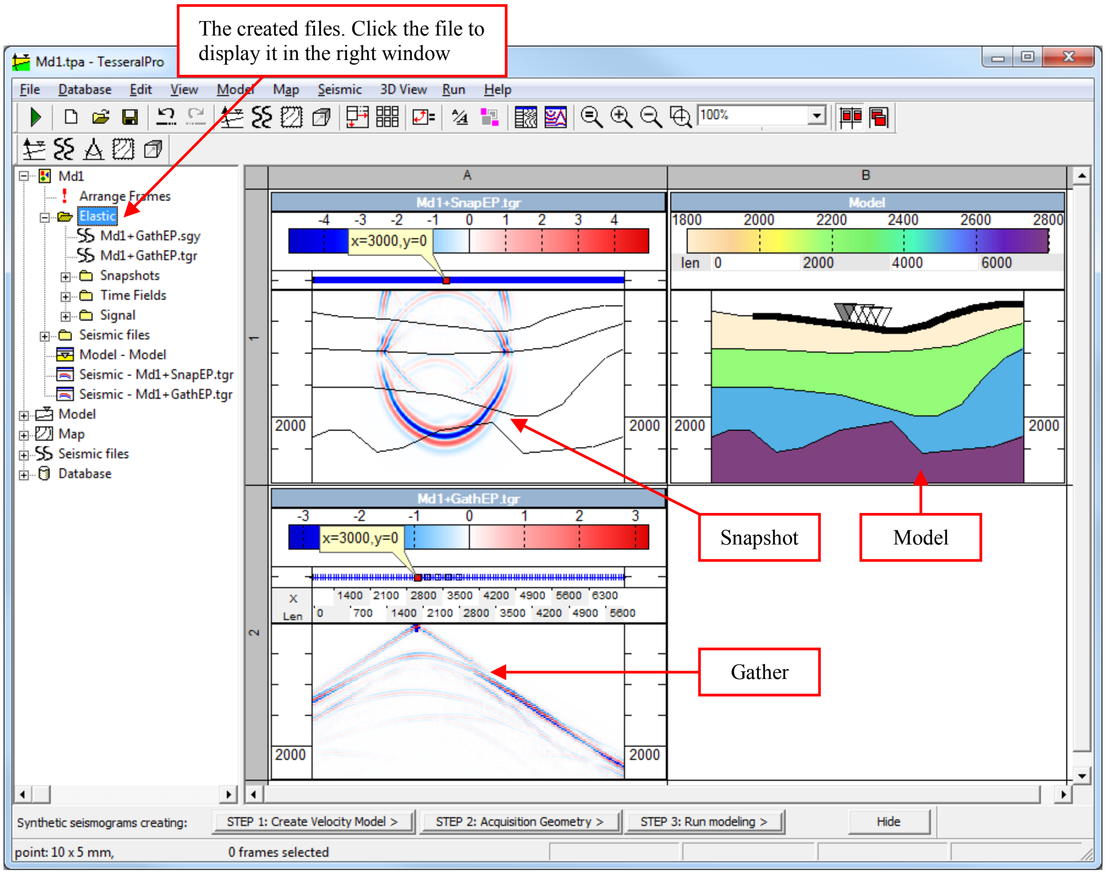
```
Snapshot dx=13
Monitor dx=13
.. Simulation started!
.. 10% (Overall: 42%) - 3 of 5.   0:00:15 elapsed.
.. 20% (Overall: 44%) - 3 of 5.   0:00:16 elapsed.
.. 30% (Overall: 46%) - 3 of 5.   0:00:16 elapsed.
.. 40% (Overall: 48%) - 3 of 5.   0:00:17 elapsed.
.. 50% (Overall: 50%) - 3 of 5.   0:00:17 elapsed.
```

In the upper part of the `Modeling in Progress` window, the percentage of computation done for the current source is shown, and the percentage of computation done for the whole job is also shown. On the left, the part of the gather being computed is shown, and on the right, the corresponding wavefield is shown. In the bottom, the log file is echoed as job is running.

If you want to terminate computation, press the `Terminate` button.

If an error occurs during the computation, the message will be shown in the lower part of the `Modeling in Progress` window. To check the log messages of a finished job, choose `Run > Show Progress Dialog` menu command.

After the modeling job is done successfully, the `Modeling in Progress` window will be closed automatically and then the computed gathers will be displayed in the Tesseral Pro window.


The created files. Click the file to display it in the right window

Snapshot

Model

Gather

Md1.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Md1
Arrange Frames
Elastic
Md1+GathEP.sgy
Md1+GathEP.tgr
Snapshots
Time Fields
Signal
Seismic files
Model - Model
Seismic - Md1+SnapEP.tgr
Seismic - Md1+GathEP.tgr
Model
Map
Seismic files
Database
A
B
Md1+SnapEP.tgr
Model
Md1+GathEP.tgr
x=3000,y=0
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 10 x 5 mm,
0 frames selected

The output files of the modeling will be created in the same folder with the project. In case of elastic isotropic modeling (Elastic Modeling), if the project is **ModelOne.tpa,** the following output files will be generated:

ModelOne+GathEP.sgy	Gather
ModelOne+GathEP.tgr	3-component gather TGR: Vertical particle velocity, Horizontal particle velocity, Normal stress
ModelOne+SnapEP.tgr	Wavefield snapshots
ModelOne+TimeEP.tgr	Traveltime from the source
ModelOne+WaveEP-1.tgr	Wavelet

Please see the Section *13* for details about outputted gathers in the Tesseral Pro.

7.5 Modeling using cluster and windows network

To use the finite difference methods (except the 2.5D Elastic Anisotropic Modeling) available in the Tesseral Pro to compute the synthetic gathers, it is enough to have a modern PC. For the 2.5D Elastic Anisotropic Modeling, the runtime can vary from several hours to several days, depending on the model size and the selected computation parameters. Due to this fact, it is recommended to use a cluster or a network of PCs to launch the 2.5D Elastic Anisotropic Modeling.

7.5.1 Modeling using a cluster

In Tesseral Pro, the model can be prepared within Tesseral Pro and the job for computation of synthetic gathers can be launched on a cluster. The cluster may work under Windows or Linux (UNIX). The Tesseral Pro package does not work directly with the cluster. It is assumed that the users copy the job and the model to the cluster explicitly, launch the job and copy the computation results back to Tesseral Pro for visualization.

To prepare the job for a cluster, call `Run > CLUSTER: Create task`. The dialogue box for job preparation is similar to the dialogue box for setting up jobs in the Tesseral Pro (see Section 7). For example, for the project **ModelOne.tpa** with 3 sources, the following files will be generated:

runtask.ini
ModelOne1.tam
ModelOne2.tam
ModelOne3.tam

Here **ModelOne1.tam**, **ModelOne2.tam**…, are the model files associated with each source. “runtask.ini” is the main file where the modeling parameters for the job are saved.

It is recommended to create an empty folder where this job will be created and saved. In this case, the benefit is that users will not need to check whether a file is related to this job or not. The 2.5D computation engine for a cluster may be downloaded from the website http://www.tesseral-geo.com under page “DOWNLOADS”. The needed user documentation is in the archive with each program.

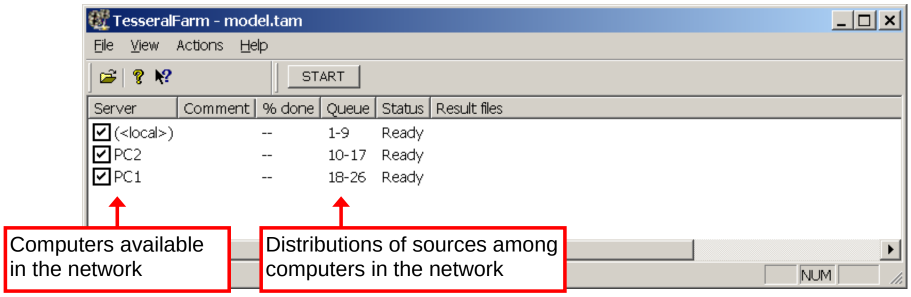
7.5.2 Modeling using Windows network

For large computation tasks, Tesseral Pro provides a special utility TesseralFarm. TesseralFarm is a utility complementary to the Tesseral Pro and it is designed to implement cluster functionality in the Windows networks. Compared to the cluster under Linux architecture, the cluster created with TesseralFarm requires far less efforts for preparation and has more flexible topology and sufficient potential for enhancement. After computers are connected to a local network and the program is tuned, the computation tasks can be broken down and allocated to each computer. TesseralFarm gives the possibility to manage computations in separate nodes and to obtain (merge) the common result.

Please see details about the installation and tuning of the TesseralFarm in separate document.

Job launch and job distribution in a Windows network is done in Tesseral Pro by calling `Run > NET: Run modeling`.

It is possible to get all computers available in the network by using `Actions > Add All Available Servers`.



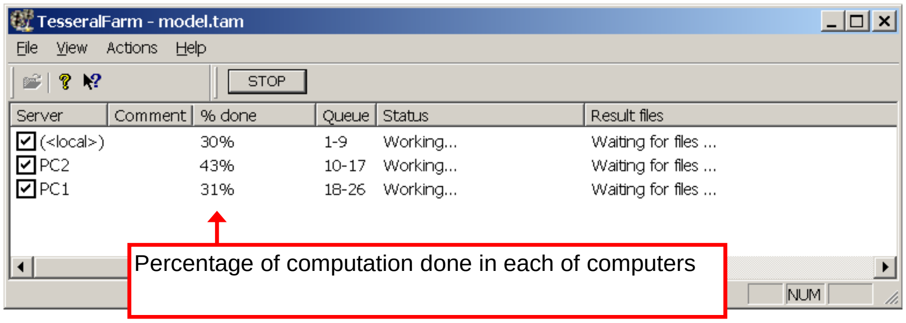
Server	Comment	% done	Queue	Status	Result files
☑ (<local>)		--	1-9	Ready	
☑ PC2		--	10-17	Ready	
☑ PC1		--	18-26	Ready	

Computers available in the network

Distributions of sources among computers in the network

Distribution of the job among the nodes (computers) is shown in the column `Queue`. For modeling, the sources allocated to each node are shown. You may change the number of sources for each node by double-clicking in the list.

When you have selected the nodes, please press `START` and the program will start copying the files to the nodes (this may happen instantaneously or may take some time, depending on the sizes of files and network speed). Once the copy of files to the nodes will be completed the computations in the nodes will begin. You can monitor the computation in each node by the messages under the column `% done`.



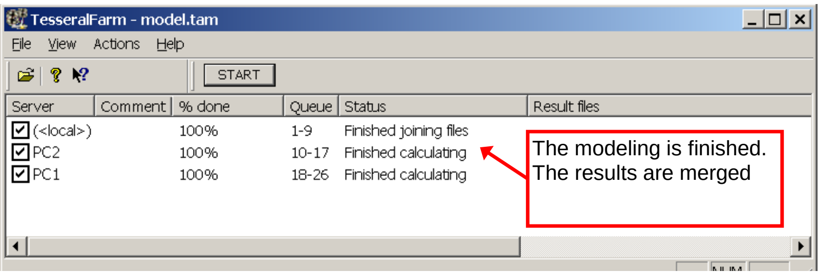
Server	Comment	% done	Queue	Status	Result files
☑ (<local>)		30%	1-9	Working...	Waiting for files ...
☑ PC2		43%	10-17	Working...	Waiting for files ...
☑ PC1		31%	18-26	Working...	Waiting for files ...

Percentage of computation done in each of computers

If you like to terminate the computations in one of the nodes, please right-click that node and select `Break calculation`.

If you like to terminate computations in all nodes, click `STOP`.

Once the computations in all the nodes are completed, the computation results are located in the folder, from which the job was launched.


TesseralFarm - model.tam
File
View
Actions
Help
START

Server	Comment	% done	Queue	Status	Result files
☑ (<local>)		100%	1-9	Finished joining files	
☑ PC2		100%	10-17	Finished calculating	
☑ PC1		100%	18-26	Finished calculating	

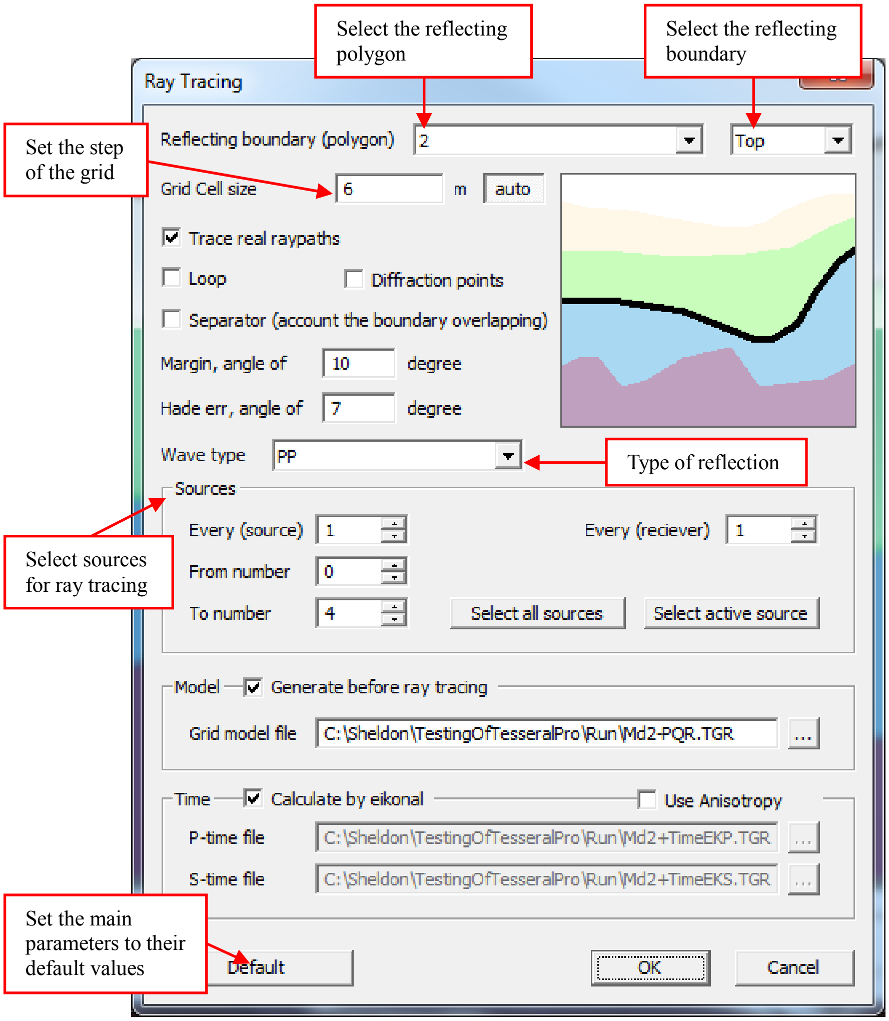
The modeling is finished.
The results are merged

8 2D Ray tracing

STEP 1. Create a new or select an existing model (the command `Model > Create Velocity Model (New Frame)` or `Edit > New Frame > Model`). The model must have sources and receivers (`Model > Acquisition Geometry`).

STEP 2. Select the polygon, for which you would like to run the ray tracing.

STEP 3. Launch the job by the command `Run > 2D Model: Ray Tracing`



Select the reflecting polygon

Select the reflecting boundary

Set the step of the grid

Type of reflection

Select sources for ray tracing

Set the main parameters to their default values

Ray Tracing

Reflecting boundary (polygon): 2 — Top

Grid Cell size: 6 m

☑ Trace real raypaths

☐ Loop ☐ Diffraction points

☐ Separator (account the boundary overlapping)

Margin, angle of: 10 degree

Hade err, angle of: 7 degree

Wave type: PP

Sources

Every (source): 1 Every (reciever): 1

From number: 0

To number: 4

Model ☑ Generate before ray tracing

Grid model file: C:\Sheldon\TestingOfTesseralPro\Run\Md2-PQR.TGR

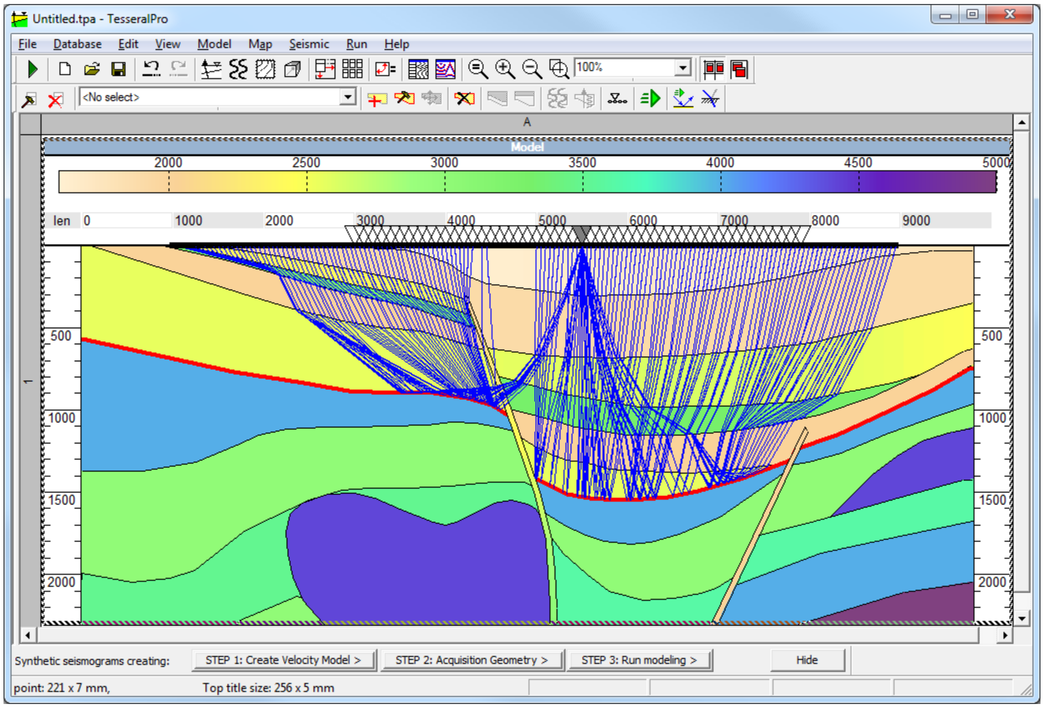
Time ☑ Calculate by eikonal ☐ Use Anisotropy

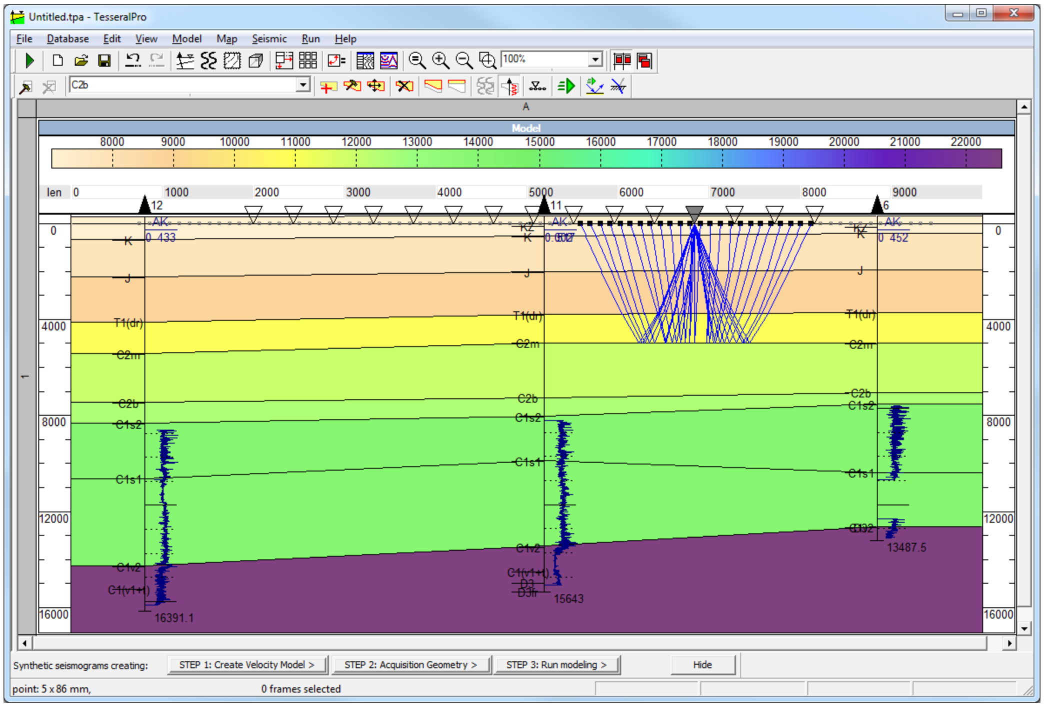
P-time file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+TimeEKP.TGR

S-time file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+TimeEKS.TGR

More information about the ray tracing parameters can be found in the section *8.3*.

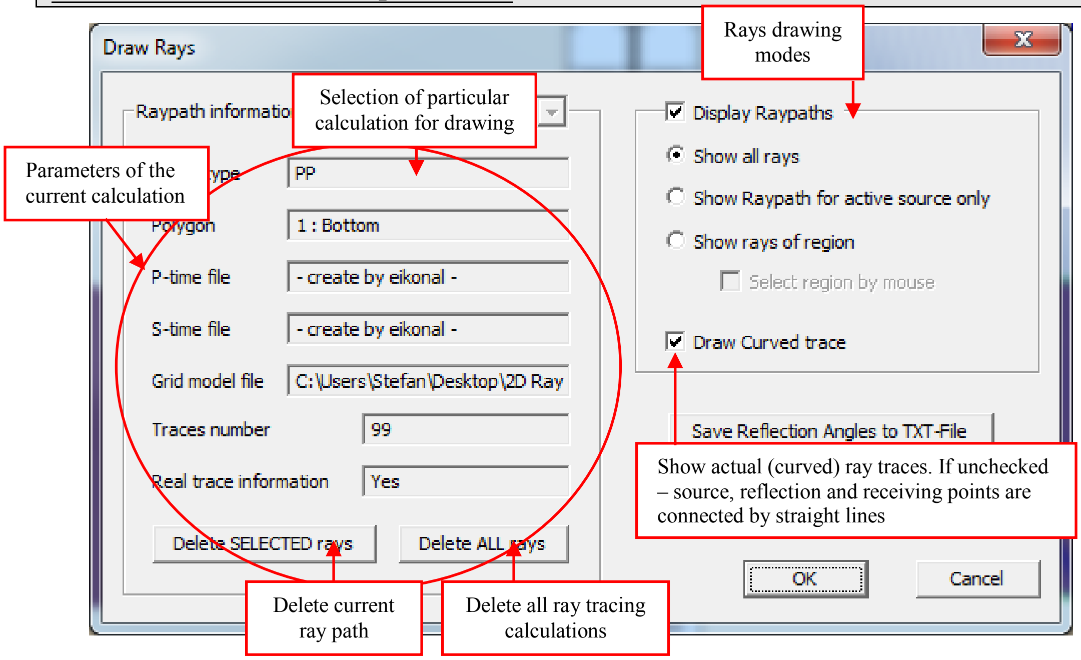
Here is the result of this method:


Untitled.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
<No select>
A
Model
2000 2500 3000 3500 4000 4500 5000
len 0 1000 2000 3000 4000 5000 6000 7000 8000 9000
500
1000
1500
2000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 221 x 7 mm,
Top title size: 256 x 5 mm


Untitled.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
C2b
A
Model
8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000 21000 22000
len 0 1000 2000 3000 4000 5000 6000 7000 8000 9000
12
11
6
AK
0 433
0 452
K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2
C1(v1+t)
0
4000
8000
12000
16000
16391.1
15643
13487.5
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 5 x 86 mm,
0 frames selected

In Tesseral Pro, the ray tracing calculations can be accumulated by repeating the command `Run > 2D Model: Ray Tracing`. If the calculation is recalled with the same parameters for the same layer, its results will automatically replace the existing results. By default, the `Model` Frame shows the result of the last calculation. The ray paths displayed in the `Model` Frame for the current calculation can be changed by using the command `Model > Raypath Data and Visualization Properties`. In the same dialogue box, you may see the parameters of the current calculation, change the mode of displaying the rays and delete some of the past calculations.

NOTE: All ray-tracing calculations are saved in the project file (".tpa" file). Please ensure that ray calculation results will not overwhelm the document. Delete the unnecessary calculations by the dialogue box `Model > Raypath Data and Visualization Properties`.


Draw Rays
Raypath informatio
Delete SELECTED rays
Delete ALL rays
Save Reflection Angles to TXT-File
OK
Cancel

type: PP
Polygon: 1 : Bottom
P-time file: - create by eikonal -
S-time file: - create by eikonal -
Grid model file: C:\Users\Stefan\Desktop\2D Ray
Traces number: 99
Real trace information: Yes

☑ Display Raypaths
● Show all rays
○ Show Raypath for active source only
○ Show rays of region
☐ Select region by mouse
☑ Draw Curved trace

Rays drawing modes

Selection of particular calculation for drawing

Parameters of the current calculation

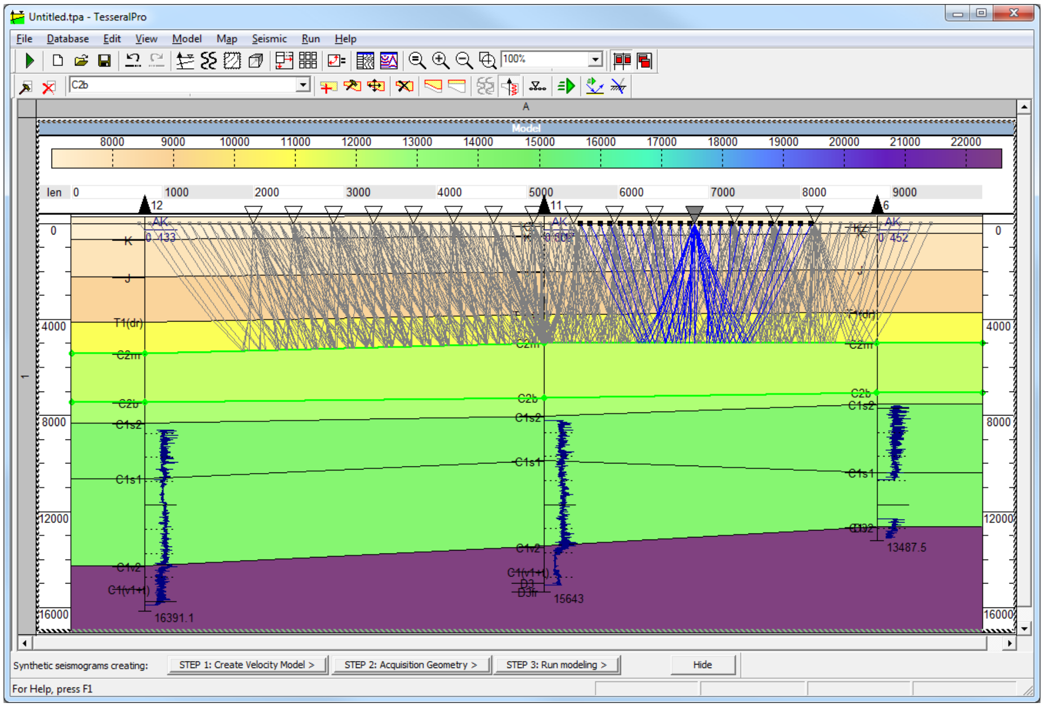
Show actual (curved) ray traces. If unchecked – source, reflection and receiving points are connected by straight lines

Delete current ray path

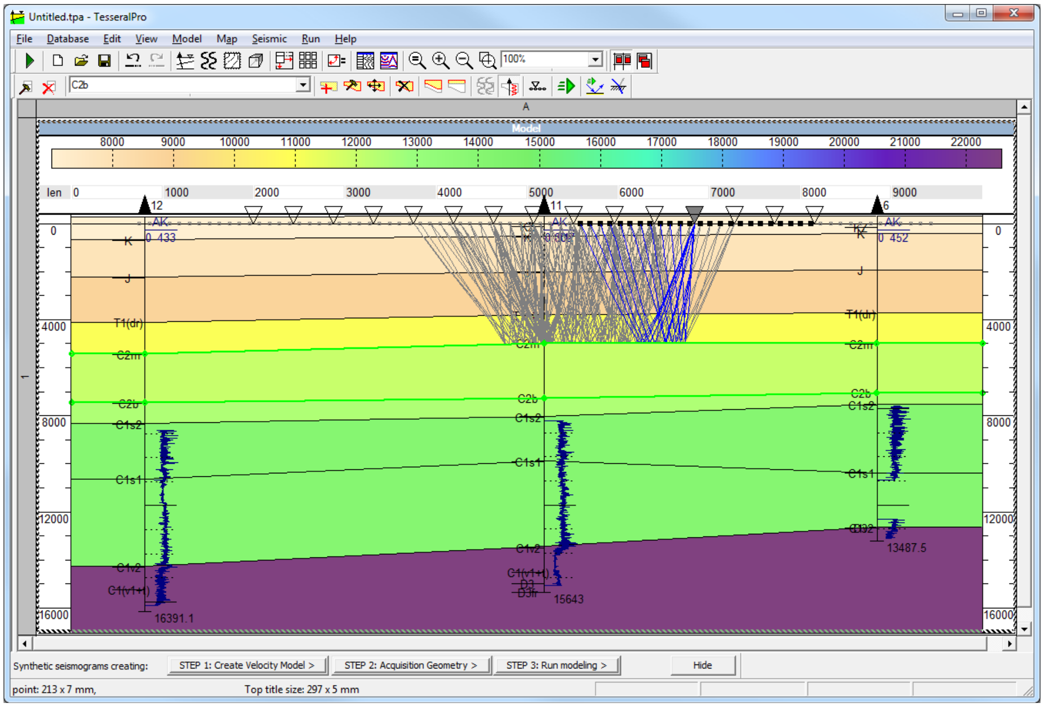
Delete all ray tracing calculations

8.1 Ray-path display in Frame Model

- `Show all rays` – The ray paths from the current calculation are shown.
- `Show Raypath for active source only` – The ray paths from the active source are shown. The ray paths from non-active sources are marked in grey color.

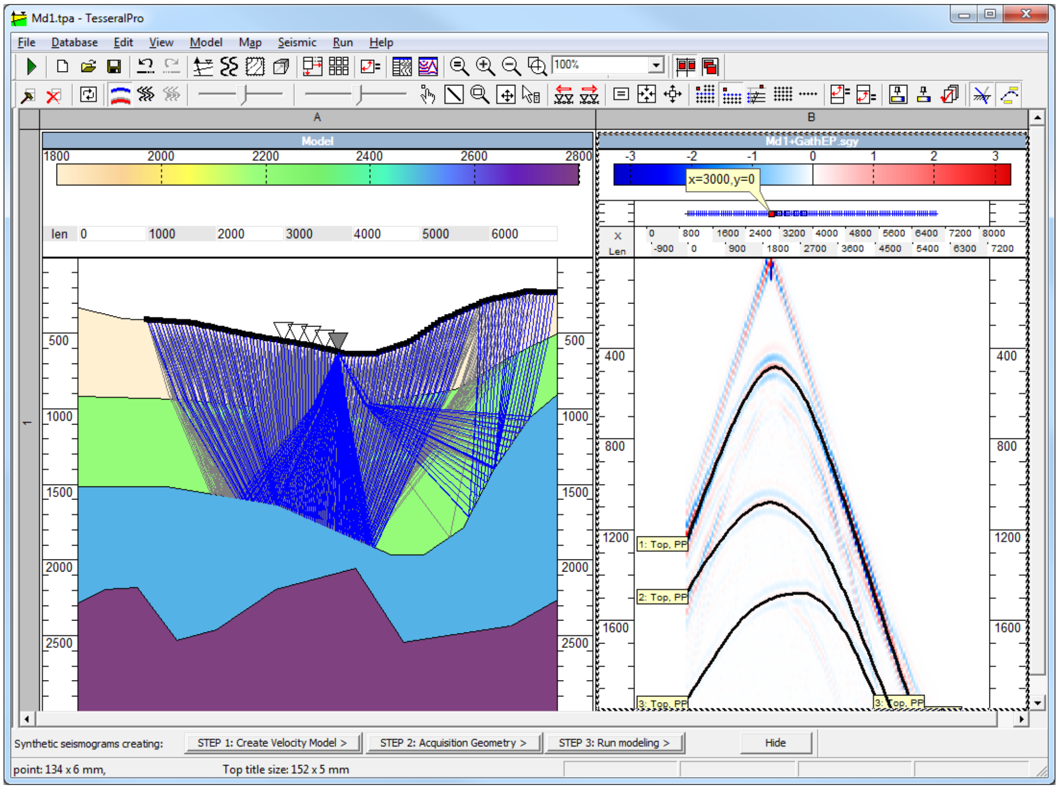

Untitled.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
C2b
Model
len
AK
K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2
C1(v1+t)
16391.1
15643
13487.5
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

- `Show rays of region` – Display the ray paths from the current calculation whose source, receiver and reflection point are within the selected area. To define the region, in the dialogue box `Model > Raypath Data Visualization Properties`, please select `Show rays of region` and then check `Select region by mouse`. Then select the region of the model for displaying rays by pressing dragging and releasing the left mouse button. The mode of the region selection will be cancelled automatically after the left mouse button is released.


Untitled.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
C2b
A
Model
8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000 21000 22000
len 0 1000 2000 3000 4000 5000 6000 7000 8000 9000
12
11
6
AK
0 433
0 452
K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2
C1(v1+t)
D3
D3fr
0
4000
8000
12000
16000
16391.1
15643
13487.5
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 213 x 7 mm,
Top title size: 297 x 5 mm

8.2 Ray-path display in gathers

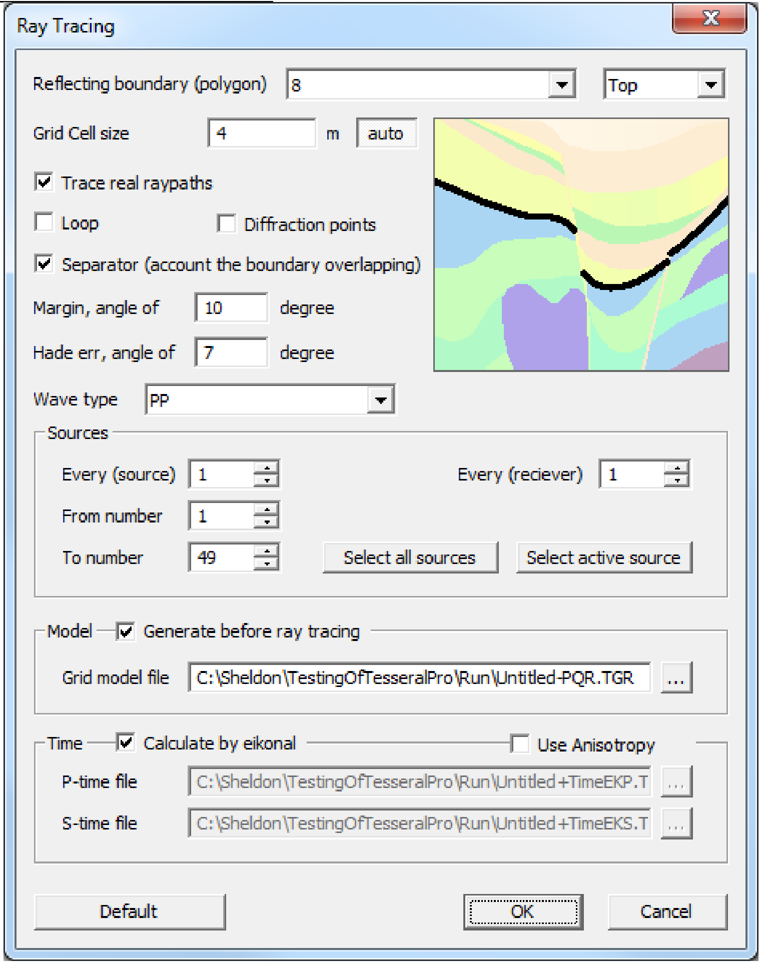
Please load the field gather or the synthetic gathers calculated by the eikonal ray tracing method or finite-difference methods into the `Seismic` Frame. It is implicitly assumed that this is the gather corresponding to the model, for which the ray-tracing was done. Please use the command `Seismic > Highlight Traced Ray Reflections` to show the ray paths in the gather.


Md1.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
A
B
Model
Md1+GathEP.sgy
x=3000,y=0
1: Top, PP
2: Top, PP
3: Top, PP
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 134 x 6 mm,
Top title size: 152 x 5 mm

The command `Seismic > Connect Ray Reflection Points` changes the mode of displaying reflection times in a gather (lines with captions or dots).

8.3 Ray-tracing parameters

Ray tracing parameters are specified in the `Ray Tracing` dialogue box, after selecting the command `Run > 2D Ray Tracing`.



Ray Tracing

Reflecting boundary (polygon) 8 Top

Grid Cell size 4 m

☑ Trace real raypaths

☐ Loop ☐ Diffraction points

☑ Separator (account the boundary overlapping)

Margin, angle of 10 degree

Hade err, angle of 7 degree

Wave type PP

Sources

Every (source) 1 Every (reciever) 1

From number 1

To number 49

Model ☑ Generate before ray tracing

Grid model file C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.TGR

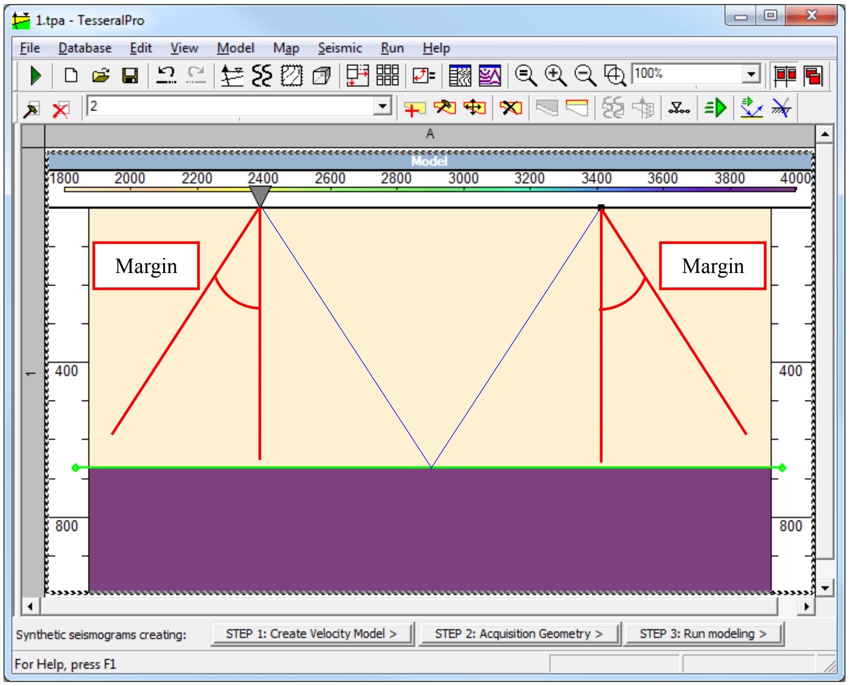
Time ☑ Calculate by eikonal ☐ Use Anisotropy

P-time file C:\Sheldon\TestingOfTesseralPro\Run\Untitled+TimeEKP.T

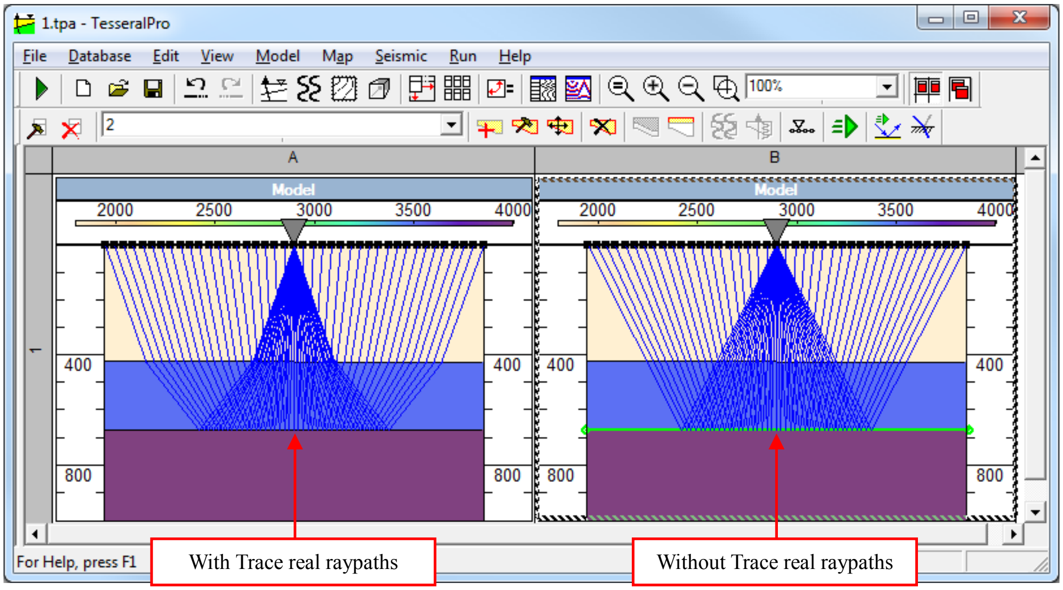
S-time file C:\Sheldon\TestingOfTesseralPro\Run\Untitled+TimeEKS.T

Main Parameters

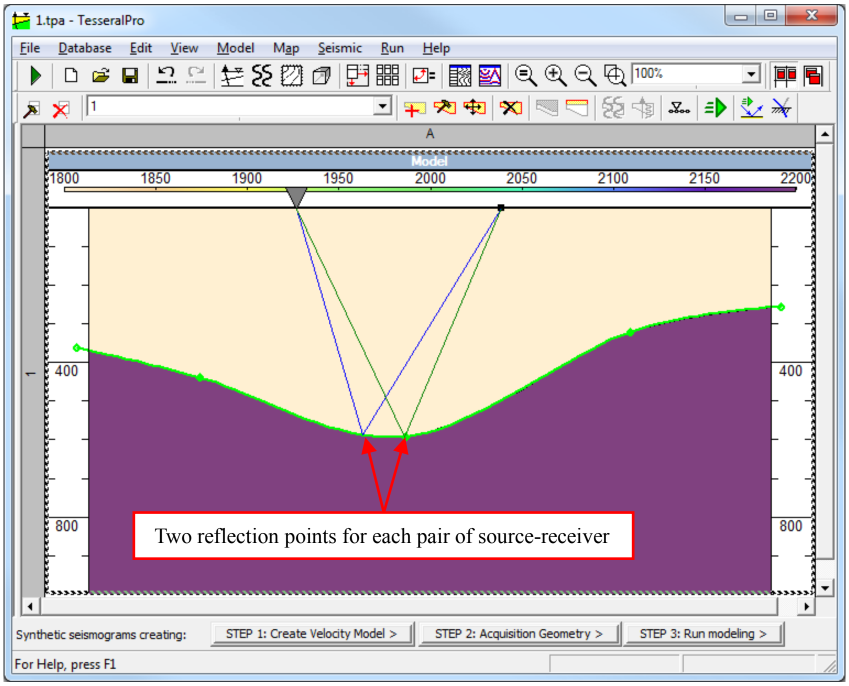
- `Reflecting boundary (polygon)` is for selecting a polygon and a reflector (top or bottom).
- `Grid Cell size` is for specifying the grid size. The bigger is the value, the faster is the calculations and the lower is the accuracy of the raypath.
- `Margin` is the maximum deflection angle.
- `Hade err, angle of` is the allowed deviation of the reflection angle from the incidence angle (i.e. allowed deviation of the law of reflection).


1.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
A
Model
1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800 4000
Margin
Margin
400
400
800
800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
For Help, press F1

- `Trace real raypaths` is for calculating the actual raypath from the source to the reflector and then back to the receivers.


1.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
A
B
Model
2000 2500 3000 3500 4000
Model
2000 2500 3000 3500 4000
400
400
400
400
800
800
800
800
For Help, press F1
With Trace real raypaths
Without Trace real raypaths

- `Separator (account the boundary overlapping)` – If the boundary is fragmented by the overlapping polygons, the calculations for each piece of the boundary are done separately for all receivers and sources. and they ray paths for each compartment will be colored differently.
- `Loop` – Up to 3 reflection raypaths are calculated for each pair of source and receiver.


1.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
Model
1800
1850
1900
1950
2000
2050
2100
2150
2200
400
800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
For Help, press F1

Two reflection points for each pair of source-receiver

- Group `Sources` – Please select the sources for which you would like to run the ray tracing. The parameter `Every (receiver)` determines the step in receivers for each source.
- Group `Time: P-time file`, `S-time file` – For the ray tracing, you can use the files of travel time that were previously calculated by any finite-difference modeling method (the command `Run > Run modeling)`.
- `Use Anisotropy` – Please check it if you want to take into account the anisotropy during the ray tracing.

NOTE: The anisotropy parameters are specified in the dialogue box for specifying the parameters of the model layers. Please select the command `Model > Edit Polygon`, and then in the dialogue box `Polygon Properties`, click the button `Anisotropy & Other Properties`.

- Group `Model` – By default, the option `Generate before ray tracing` is checked because calculation of the model may be long (if the velocity for the model polygons is calculated by well log curves). If the model has not been changed since the last ray tracing or modeling, the new model calculation is not required and you may leave the checkbox `Generate before ray tracing` unchecked.
- The button `Default` is to set the default parameters and file names automatically.

9 3D Ray-tracing

To perform 3D Ray-tracing in Tesseral Pro it is necessary to have a 3D Velocity Model in SEG-Y format (see 13.4), reflecting surface in one of standard formats (see ***14.1***) and 3D survey layout (see ***9.1***)

You can see explanations on how to create a job and run 3D Ray-tracing in Chapter ***9.2***

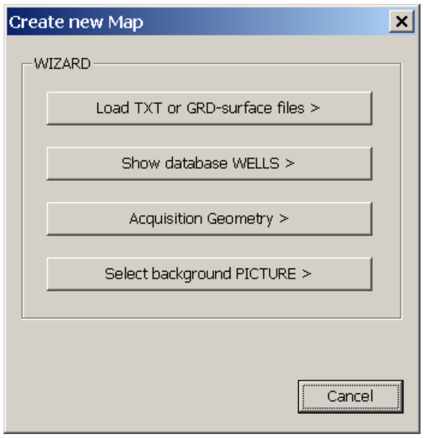
You can find some specifics of viewing modeling results in Chapter ***15***.

9.1 3D survey

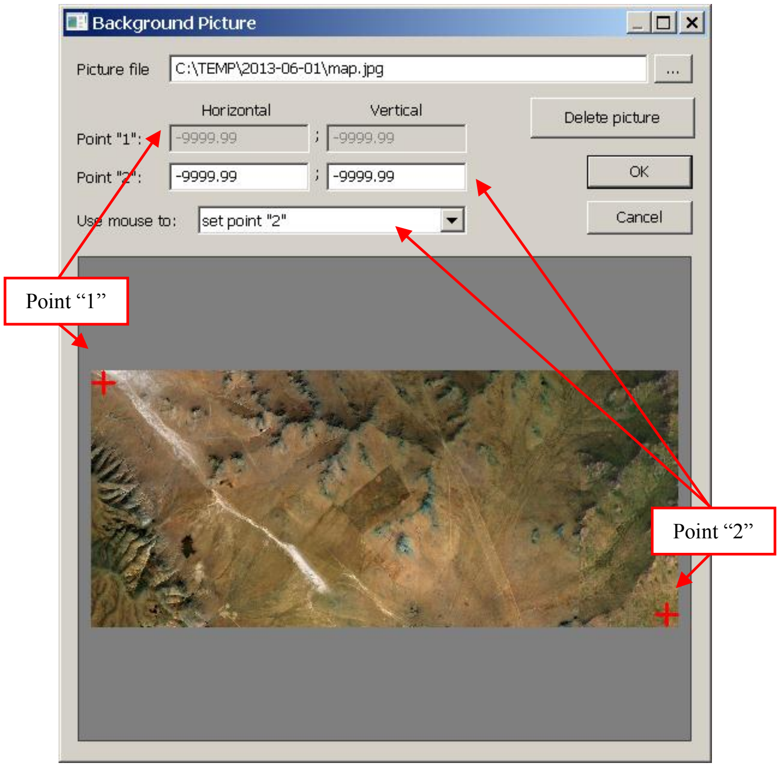
3D survey design in Tesseral Pro can be done manually or a survey can be loaded from standard SPS-file. First of all you need to create a frame Map with topographic background taken from picture (see 9.1.1). If you create a 3D survey design manually, you should use the option `Map/Acquisition geometry` to choose the pattern and basic parameters for 3D survey (see 9.1.2). Use `Map/3D survey modes` menu command to adjust your design parameters and layout to match the real topographic map (see ***9.1.3***).

9.1.1 Load Map using backgroud picture.

Command: `Map/Create Map (new frame)`.


Create new Map
WIZARD
Load TXT or GRD-surface files >
Show database WELLS >
Acquisition Geometry >
Select background PICTURE >
Cancel

In the dialog `Create new Map`, press `Select background PICTURE` or `Load TXT or GRD-surface files` (see section **14** for the latter). Choose the picture file with the desired topographic map. Tesseral Pro supports the following picture formats: BMP, JPEG, TIFF, GEO-TIFF, GEO-JPEG with coordinates in TFW, JGW files.


Background Picture
Horizontal
Vertical
Delete picture
OK
Cancel
Point “1”
Point “2”

Picture file: C:\TEMP\2013-06-01\map.jpg

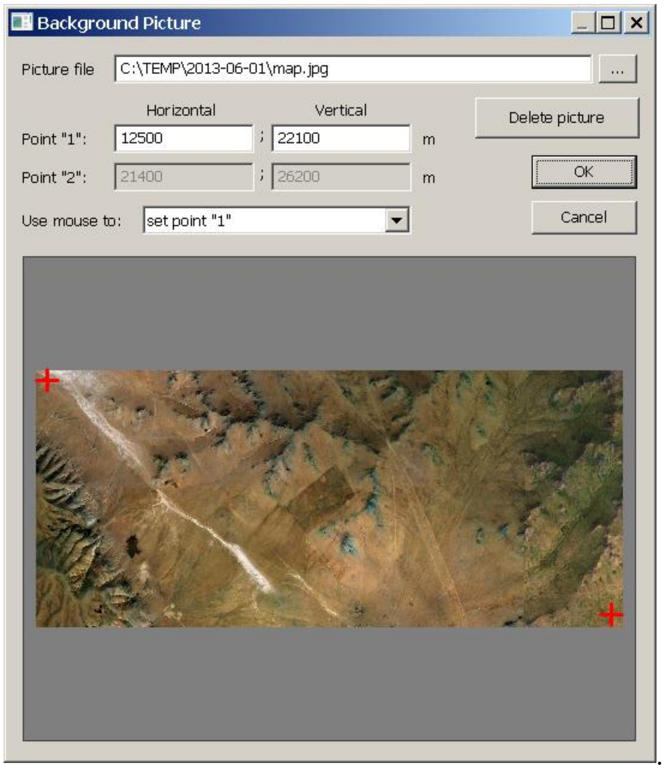
Point "1": -9999.99 ; -9999.99

Point "2": -9999.99 ; -9999.99

Use mouse to: set point "2"

You need to input coordinates for two base points in the `Background Picture` dialog to align this picture with the real topographic map. You can move these points manually in the lower part of this dialog using the mouse. For example, when you click mouse and choose `Point "2"`, the `Horizontal` and `Vertical` edit boxes become enabled for inputting applicable coordinates. The same will be true for `Point "1"`.

Let’s input coordinates for two points using this picture:


Background Picture

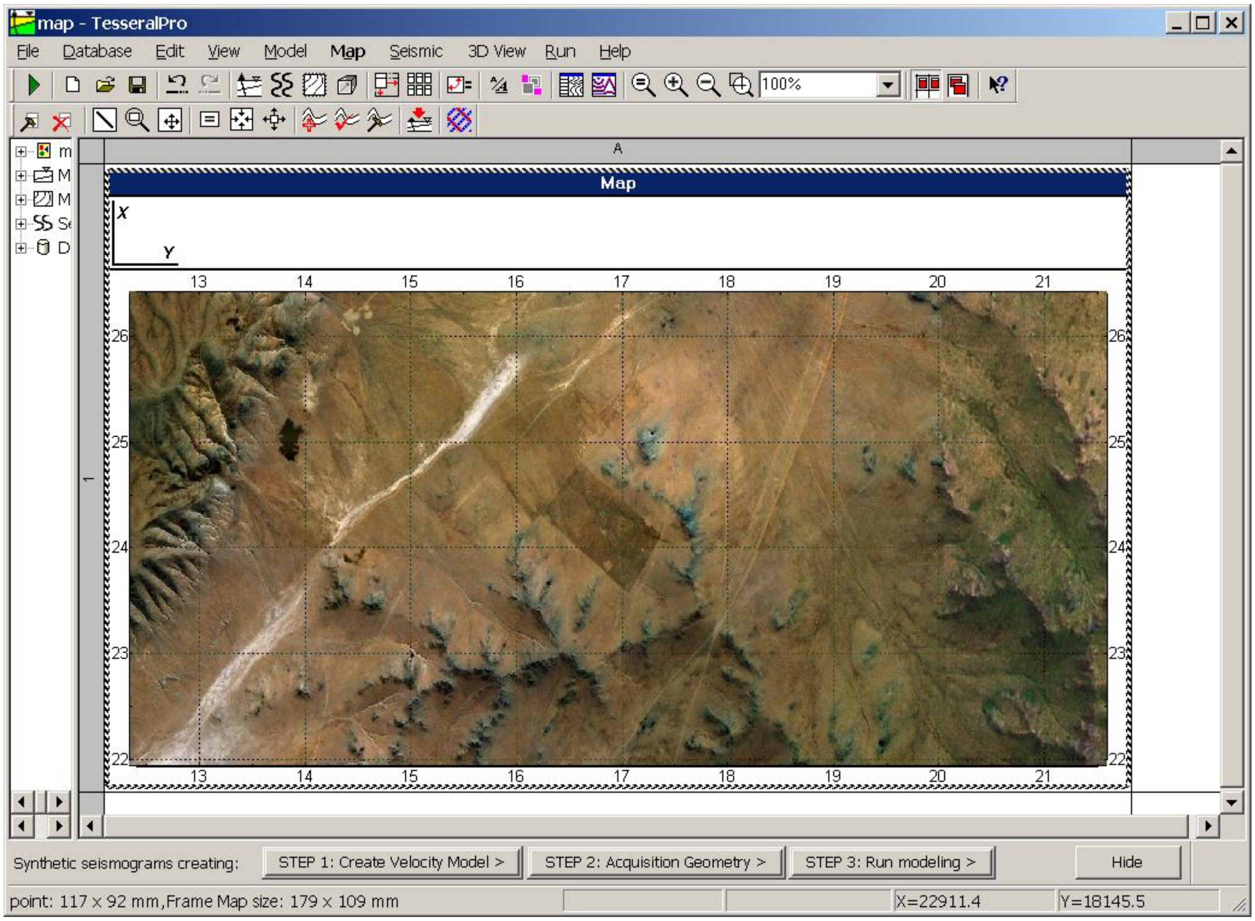
Picture file: C:\TEMP\2013-06-01\map.jpg

	Horizontal		Vertical	
Point "1":	12500	;	22100	m
Point "2":	21400	;	26200	m

Use mouse to: set point "1"

...
Delete picture
OK
Cancel

Result:


map - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
A
Map
X
Y
13
14
15
16
17
18
19
20
21
26
25
24
23
22
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

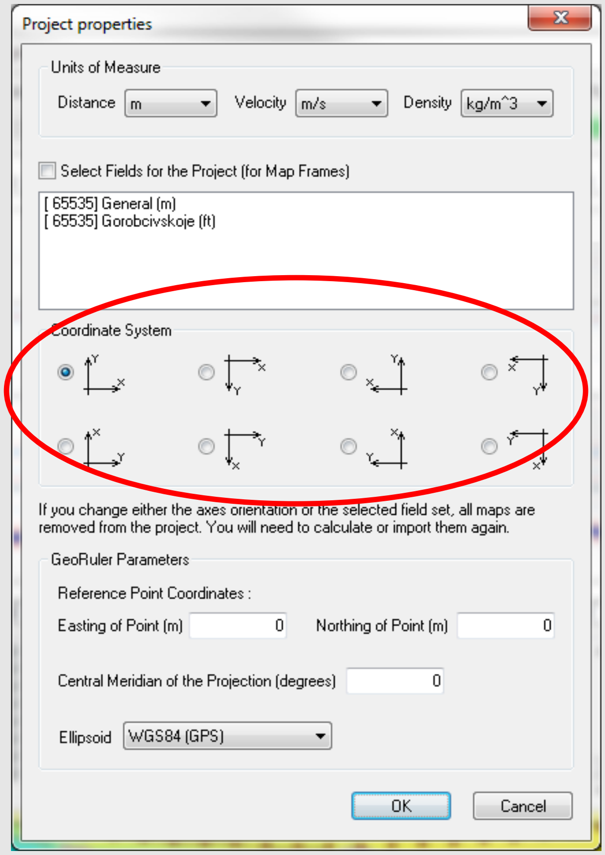
Synthetic seismograms creating:

point: 117 x 92 mm,Frame Map size: 179 x 109 mm

X=22911.4

Y=18145.5

NOTE: Please remember that map axis’s orientation can be specified in the `File/Project Properties` dialog:


Project properties
Units of Measure
Coordinate System
GeoRuler Parameters
Reference Point Coordinates :
OK
Cancel

Distance: m
Velocity: m/s
Density: kg/m^3

☐ Select Fields for the Project (for Map Frames)

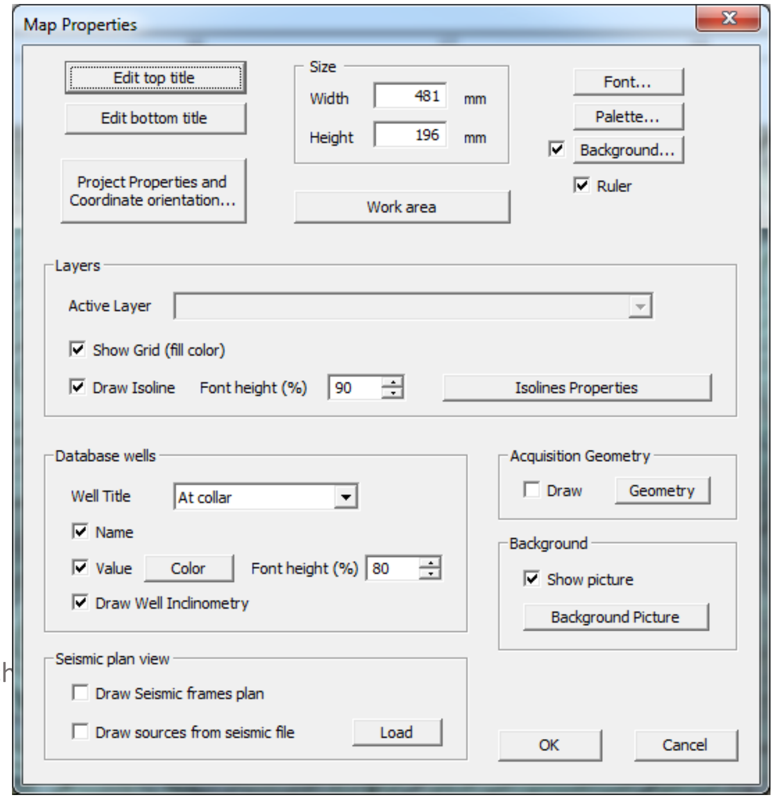
[65535] General (m)
[65535] Gorobcivskoje (ft)

If you change either the axes orientation or the selected field set, all maps are removed from the project. You will need to calculate or import them again.

Easting of Point (m): 0
Northing of Point (m): 0
Central Meridian of the Projection (degrees): 0
Ellipsoid: WGS84 (GPS)

In Tesseral Pro the background picture for the map cannot be rotated to 90°, but it can be mirrored in relation to vertical/horizontal axis (flipped). Because of that, you put coordinates of base points in `Background Picture` dialog not as X and Y values, but as a distance along vertical and horizontal axis.

To create virtual coordinates in “background picture” you need to choose frame Map and choose command `Edit/Edit Frame Properties`. In the `Map Properties` dialog press the `Background Picture` button in the `Background` group:


Map Properties
Edit top title
Edit bottom title
Project Properties and Coordinate orientation...
Size
Work area
Font...
Palette...
Background...
Layers
Isolines Properties
Database wells
Acquisition Geometry
Geometry
Background
Background Picture
Seismic plan view
Load
OK
Cancel

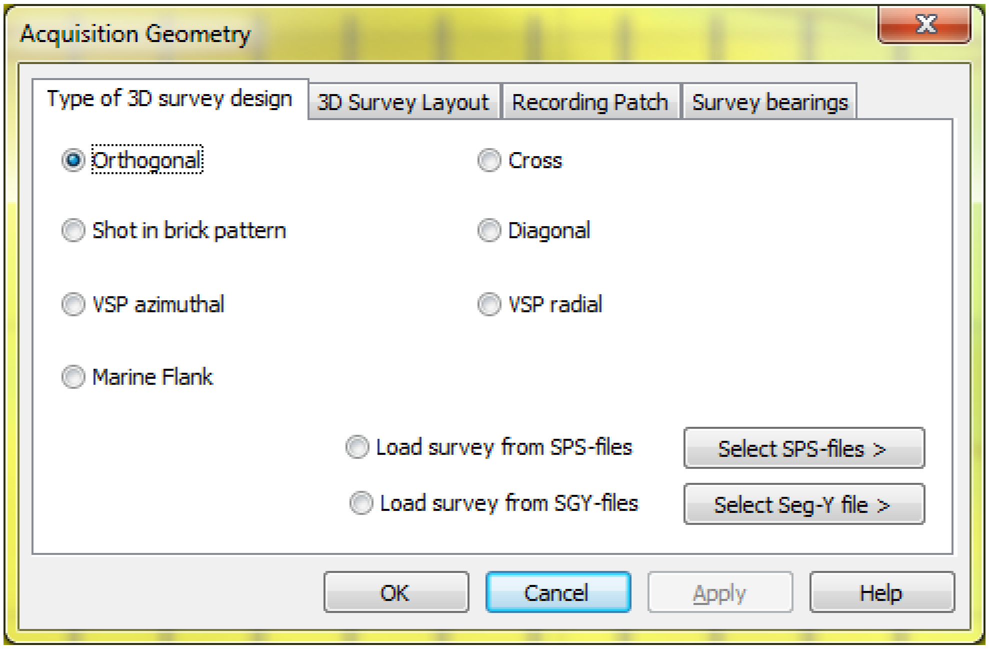
Width: 481 mm
Height: 196 mm
☑ Background...
☑ Ruler
Active Layer:
☑ Show Grid (fill color)
☑ Draw Isoline   Font height (%): 90
Well Title: At collar
☑ Name
☑ Value   Color   Font height (%): 80
☑ Draw Well Inclinometry
☐ Draw
☑ Show picture
☐ Draw Seismic frames plan
☐ Draw sources from seismic file

If you want to hide the background picture and not show it in frame `Map`, you should use `Frame Map Properties`, and click option `Show Picture`. To remove background picture press `Background Picture` and `Delete Picture`.

Now you can use the created Map frame for the 3D survey design.

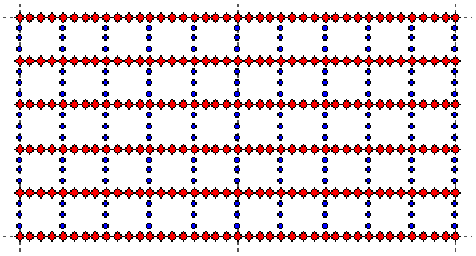
9.1.2 Choose 3D survey design.

Select the <u>`Map/Acquisition Geometry`</u> menu command.

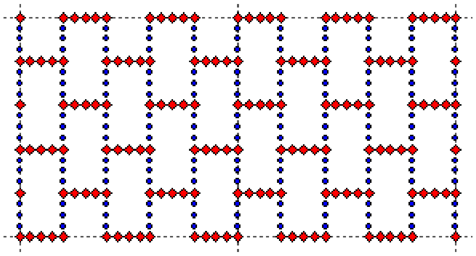

Acquisition Geometry
Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings
● Orthogonal
○ Cross
○ Shot in brick pattern
○ Diagonal
○ VSP azimuthal
○ VSP radial
○ Marine Flank
○ Load survey from SPS-files
Select SPS-files >
○ Load survey from SGY-files
Select Seg-Y file >
OK
Cancel
Apply
Help

Tesseral Pro can support 4 types of 3D survey design.

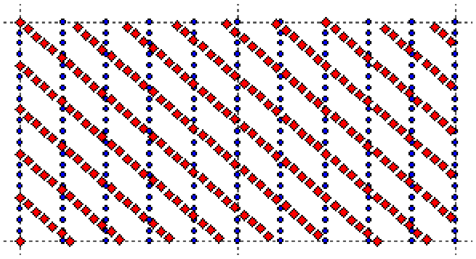
1) Orthogonal



2) Shot in crankshaft pattern

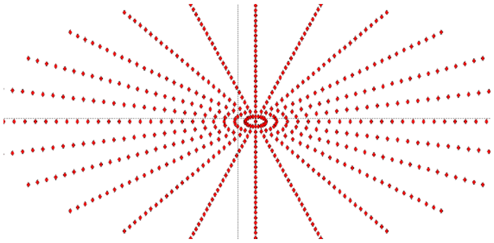


3) Diagonal

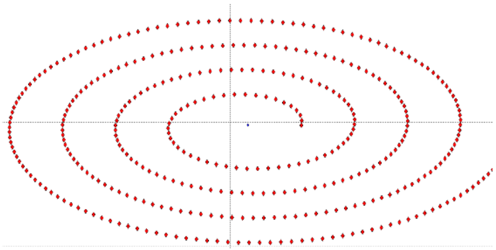


4) Load survey from SPS-files (see *9.1.7*)

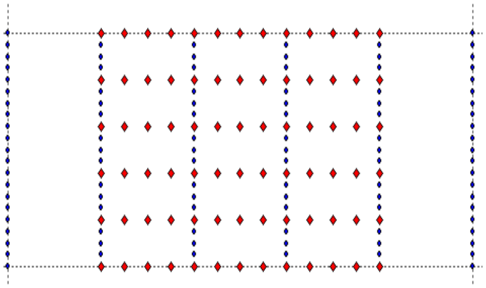
5) Load from SGY-files (see *9.1.7*)
6) VSP azimuthal



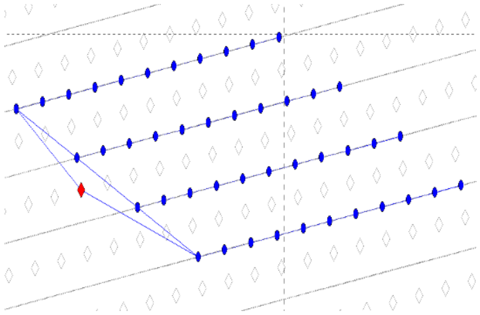
7) VSP radial



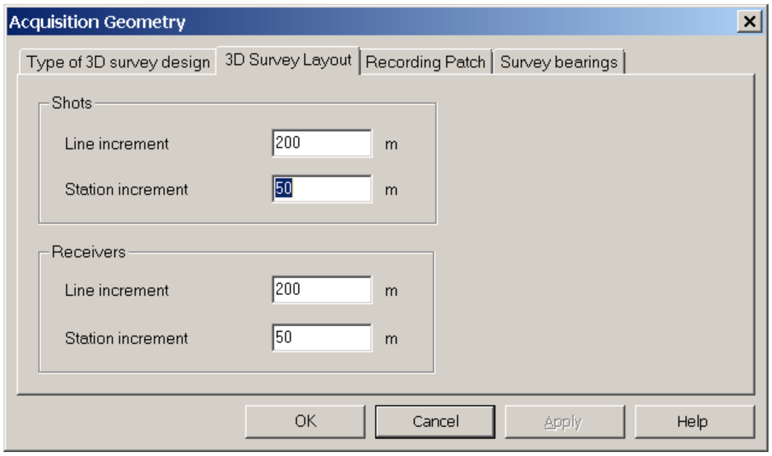
8) Cross



9) Marine flank



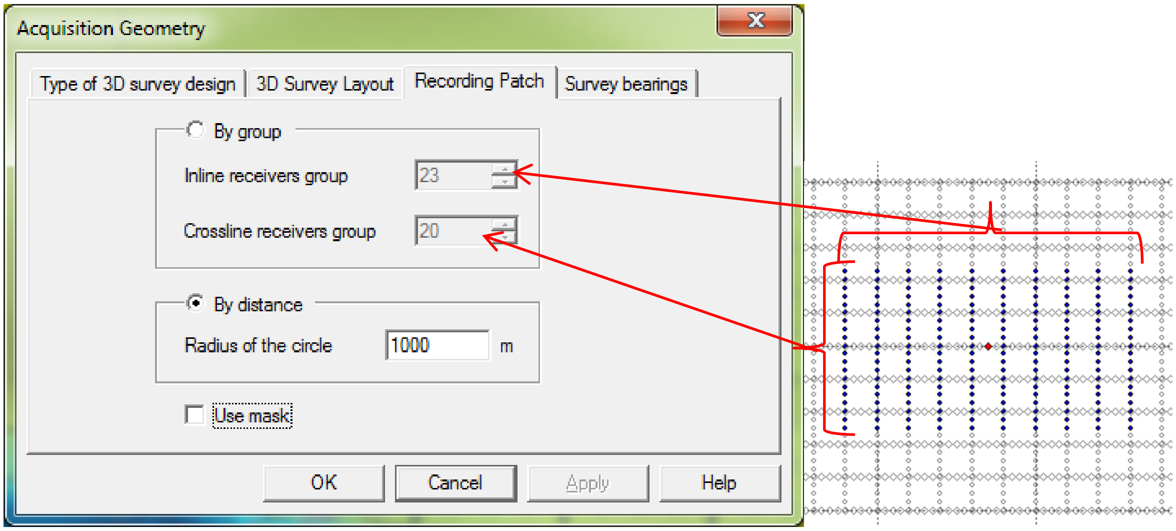
`In the` <u>`3D Survey`</u> <u>`Layout`</u> tab you can specify the increment between Shot and Receiver Lines and their stations.


Acquisition Geometry
Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings
OK
Cancel
Apply
Help

Shots
Line increment 200 m
Station increment 50 m

Receivers
Line increment 200 m
Station increment 50 m

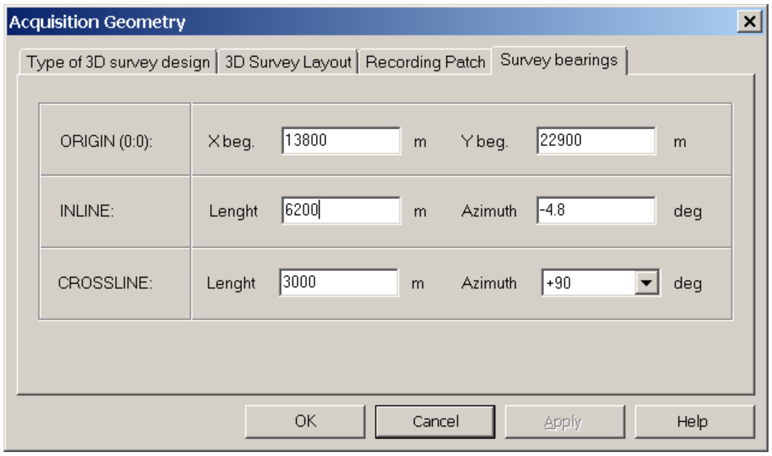
In the `Recording Patch` tab you can specify the number of receivers engaged with every shot. In `Inline receivers group` and `Crossline receivers group` you can specify the number of receivers nearest to a shot which fall into this group. If you choose the `By Distance` group you need specify the `Radius of the circle` which will enclose all receivers around the shot point.


Acquisition Geometry
Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings
OK
Cancel
Apply
Help

○ By group
Inline receivers group 23
Crossline receivers group 20
● By distance
Radius of the circle 1000 m
☐ Use mask

NOTE: You can design recording patch of any shape using options `Remove Receivers from Shot` and `Add Receivers to Shot`. These options can assign receivers to a recording patch. In this case the `Recording Patch` dialog of the `Acquisition Geometry` you can click `Use mask`, and `Inline receivers group` and `Crossline receivers group` will be ignored and a newly designed recording patch will be used for the whole survey.

In `Survey bearings` you can specify the dimensions and direction of 3D survey.



Acquisition Geometry

Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings

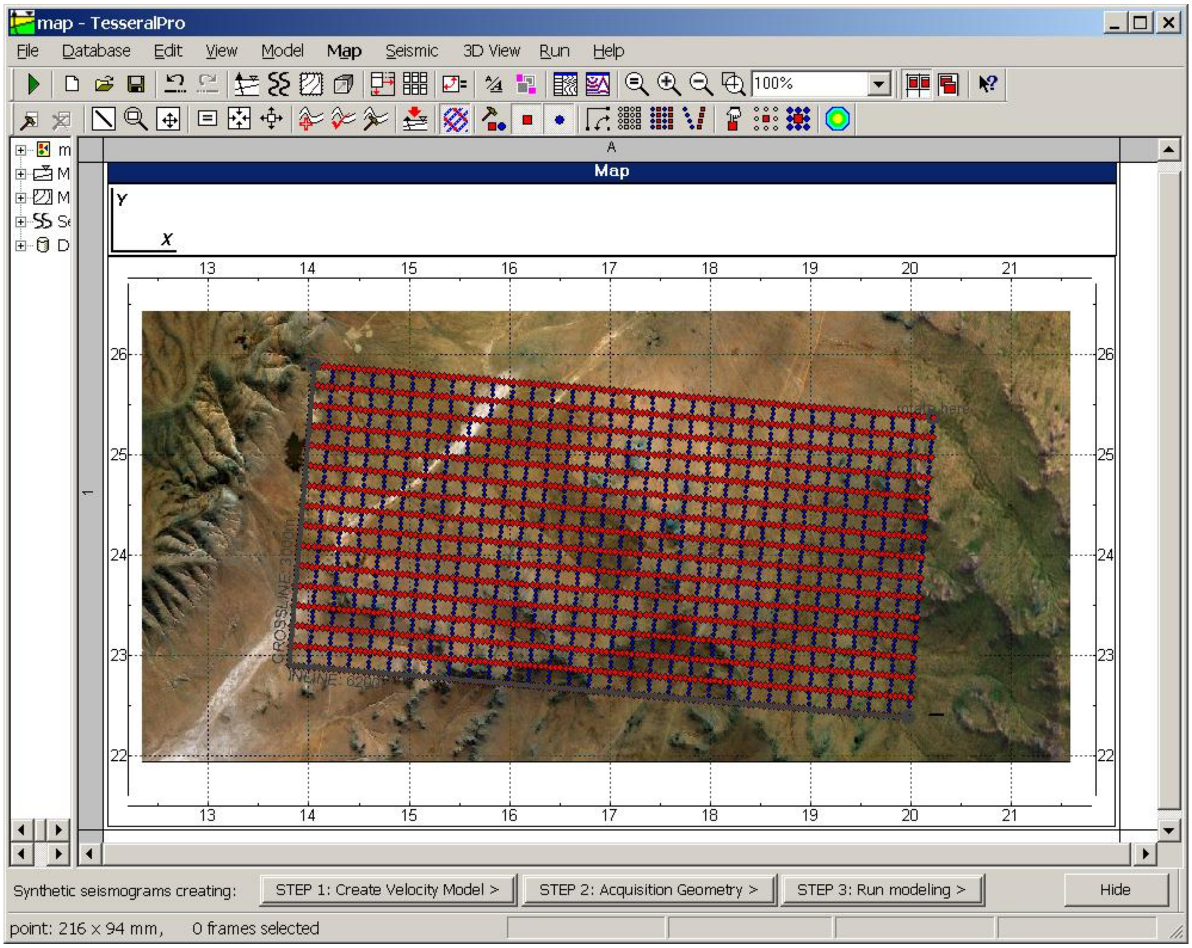
ORIGIN (0:0): X beg. 13800 m Y beg. 22900 m

INLINE: Lenght 6200 m Azimuth -4.8 deg

CROSSLINE: Lenght 3000 m Azimuth +90 deg

OK
Cancel
Apply
Help

Result:

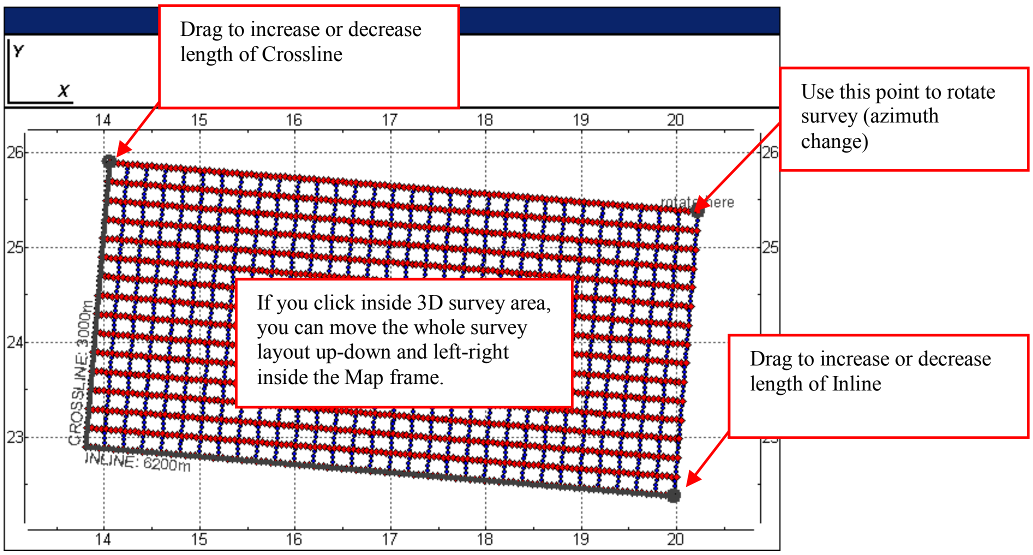


map - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
A
Map
Y
X
13
14
15
16
17
18
19
20
21
26
25
24
23
22
CROSSLINE: 3000m
INLINE: 6200
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 216 x 94 mm,
0 frames selected

NOTE: The coordinates of the 3D survey's Origin Point (`X beg`., `Y beg.`), `INLINE/CROSSLINE Length` and `Azimuth` can be assigned "visually" in the `Map` frame using `Map/Section Mode command`. Draw a profile line using left mouse button (click-draw-release) and open the `Map/Acquisition Geometry` dialog. If you are creating a 3D survey for the first time the direction of this survey will coincide with the direction of the line which you have just drawn. If you want to change the dimension or direction of an already created survey then using the mouse you need to select the command `Map/3D survey Modes/Moving with rotation`. See the instructions below...

9.1.3 Move and Rotate 3D survey.

The `Map/3D survey Modes/Moving with rotation` command is used to correct the 3D survey positioning on a map. Use left mouse button (click- drag-release).



Drag to increase or decrease length of Crossline

Use this point to rotate survey (azimuth change)

If you click inside 3D survey area, you can move the whole survey layout up-down and left-right inside the Map frame.

Drag to increase or decrease length of Inline

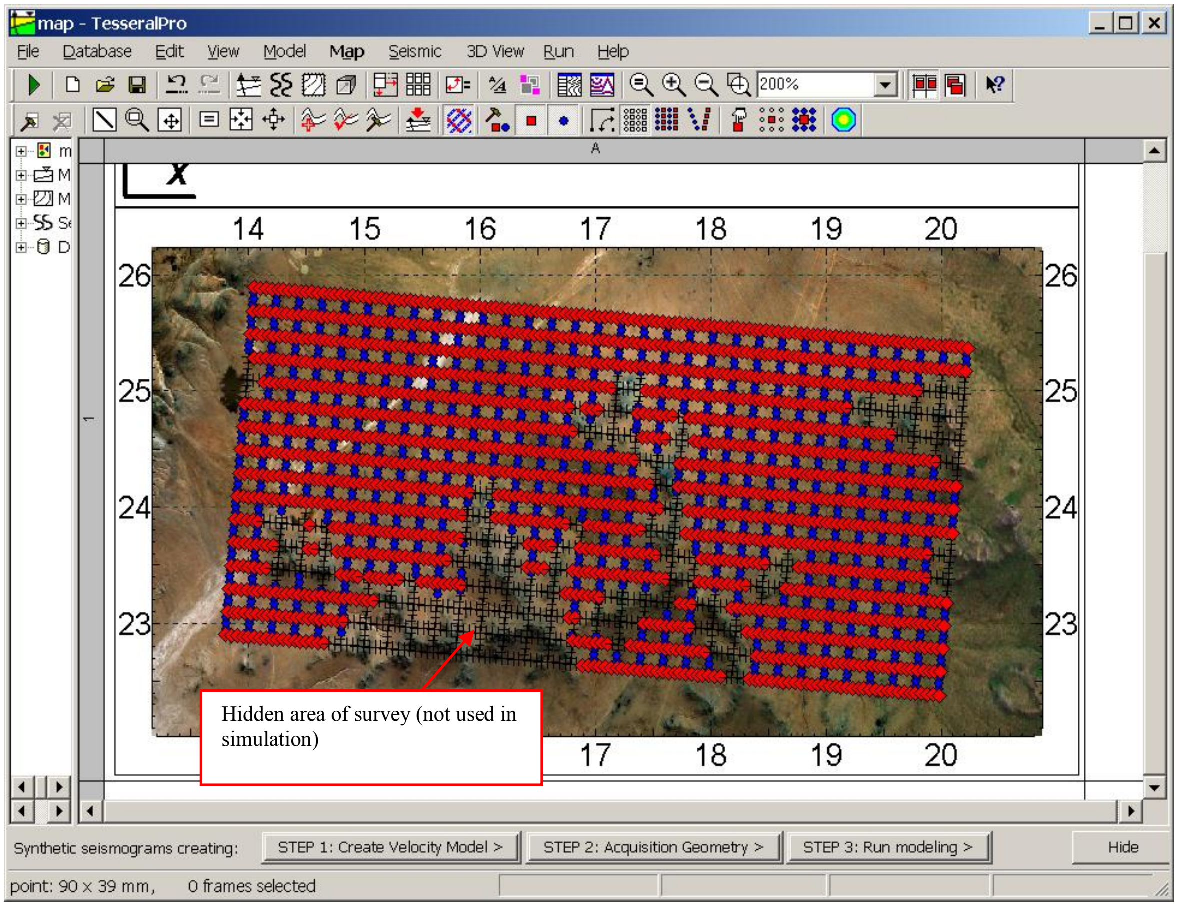
Y
X
14
15
16
17
18
19
20
26
25
24
23
rotate here
CROSSLINE: 3000m
INLINE: 6200m

9.1.4 Edit Shot and Receiver Stations.

Option Map/3D survey Modes/Hide is used to hide not needed Shots or/and Receivers from a 3D survey. Press the left mouse button, hold it and select the area which you want to hide. Hidden Shots/Receivers will not take part in the following 3D survey design. Hidden Shots will be shown on the Map frame as squares and Receivers – as circles.

If you want to bring hidden Shots/Receivers back into survey you need to use option Map/3D survey Modes/Show. This option works the same way: click--drag-release.

Result:

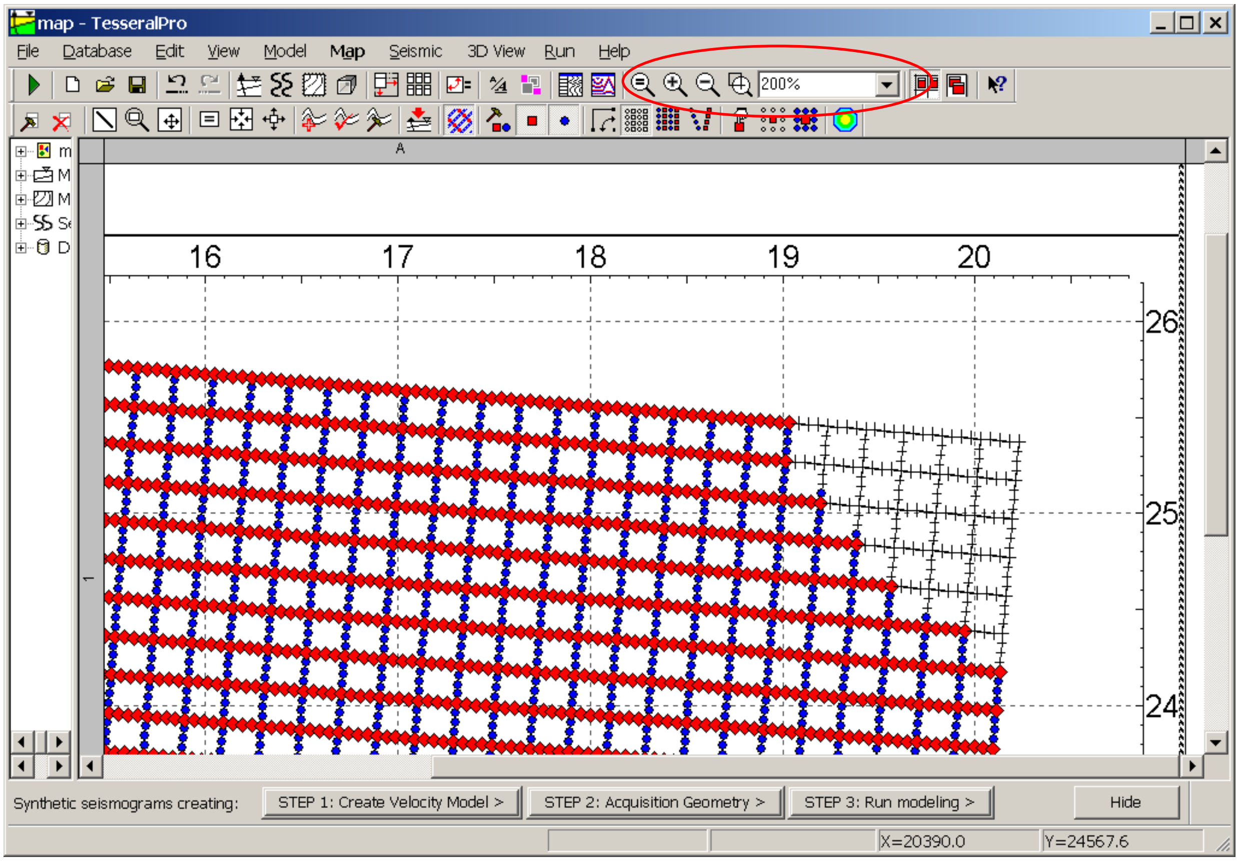


map - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
200%
A
X
14
15
16
17
18
19
20
26
25
24
23
17
18
19
20
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 90 x 39 mm,
0 frames selected

Hidden area of survey (not used in simulation)

NOTE: If you want to use options Hide/Show separately for Shots and Receivers (for example, to hide a group of shots, but to leave receivers there), you need to check Map/Show Shots or Map/Show Receivers respectively. As a result Shots or Receivers will not be shown in theMap frame, and editing will be possible only for shown elements (shots or receivers).

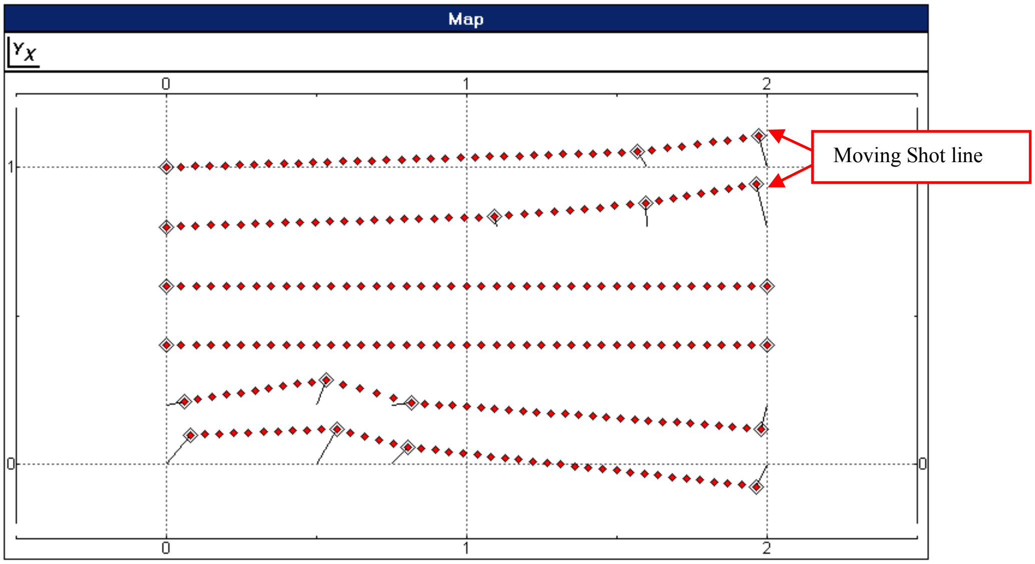
In order to increase or decrease the editing precision use the scaling option in the View/Zoom command.


map - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
200%
A
16
17
18
19
20
26
25
24
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
X=20390.0
Y=24567.6

9.1.5 Change Direction for Shot and Receiver Lines.

Using the menu command Map/`3D survey Modes/Moving Shot and Receiver lines` you can change the shape for Shot and Receiver Lines in order to adjust them to a real land topography.

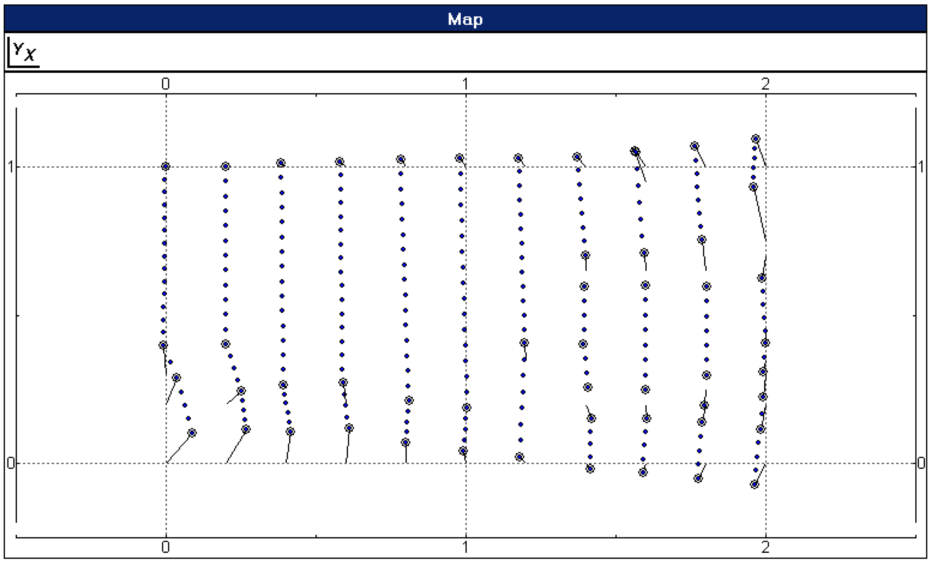
To show this example without obstacles, the background picture has been hidden (in dialog `Frame Map Properties` we clicked off `Show Picture`), Receivers were hidden as well (clicked off `Map/Show Receivers`).



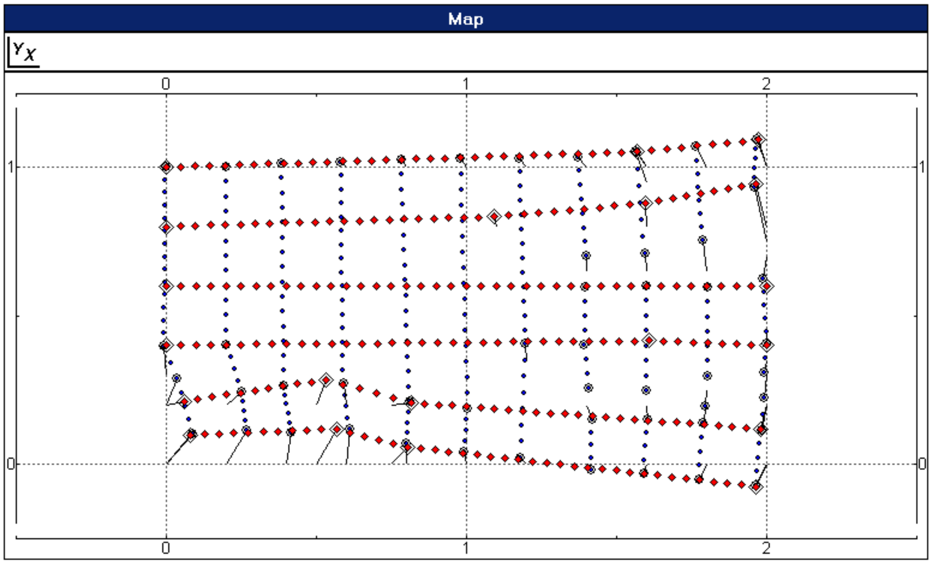
After the creation of the first 3D surveyeach Shot/Receiver Line has two "anchor" points which tie a line to its plane position. So you can:

1) Change the "anchor" position using the left mouse button (click-pull-release);
2) Remove an "anchor" by double clicking of the left mouse button;
3) Add a new "anchor" - click the left mouse button at any shot point.

The same can be applied for Receiver Lines:



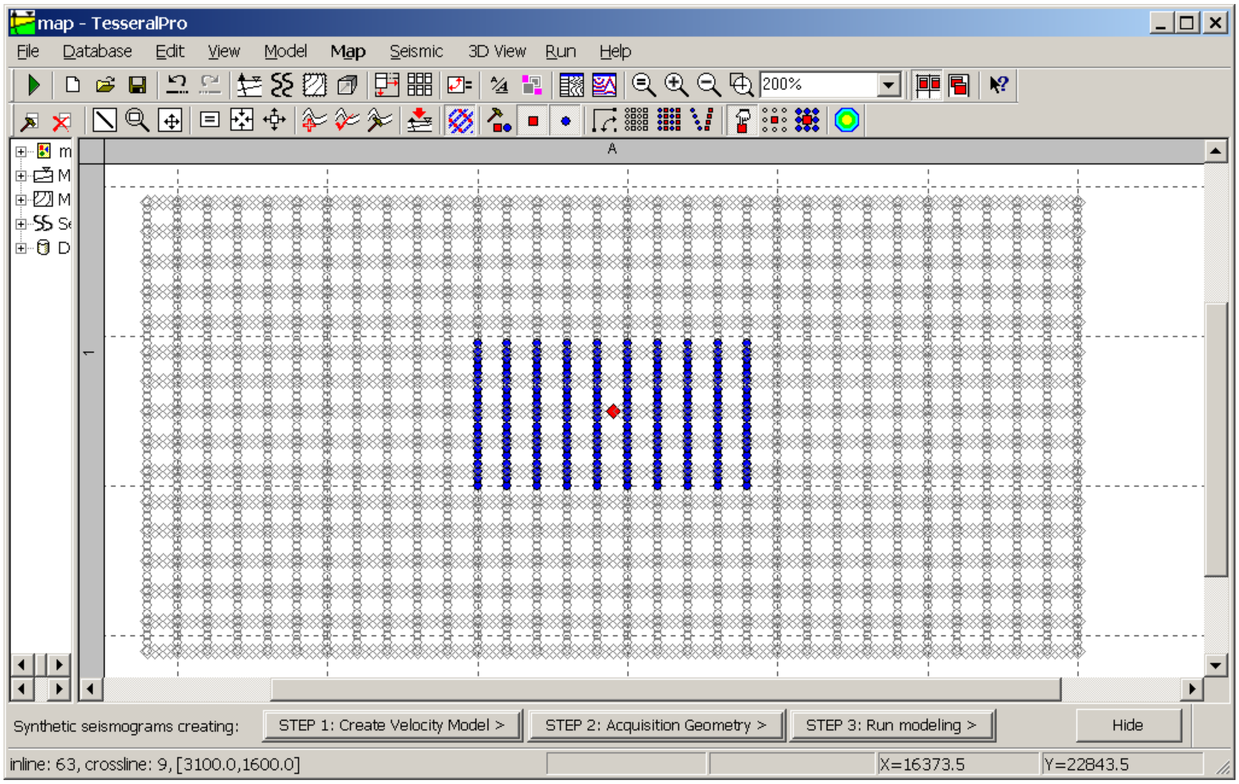
Shot and Receiver Lines can be moved independently or together:


Map
Y X
0
1
2
1
0
1
0
0
1
2

9.1.6 3D recording patch design.

First of all you need to specify a recording patch for each shot in `Map/Acquisition Geometry` dialog in the `Recording Patch` tab (see *9.1.2*). `Inline receivers group` and `Crossline receivers group` parameters identify the number of nearest receivers which will be assigned to the current source.

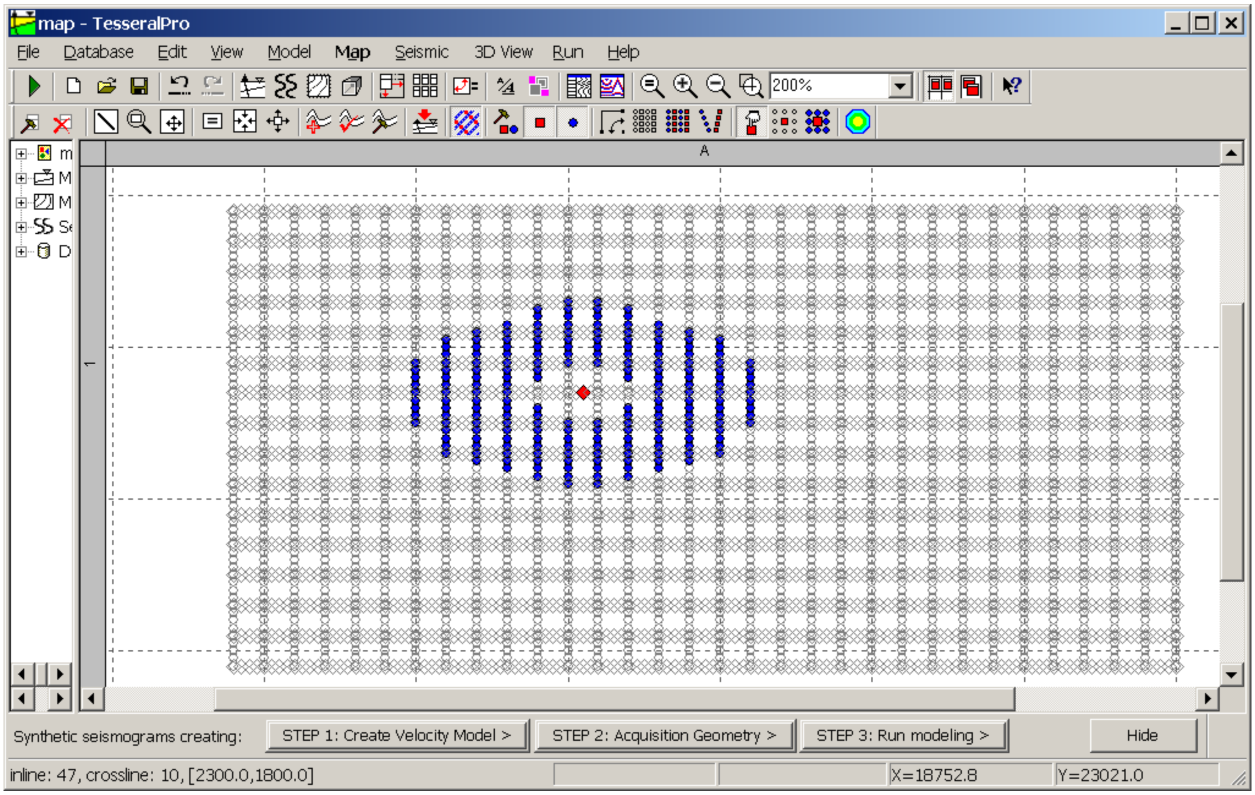
You can change a shape of recording patch using mask and apply it for the entire survey. First of all you need to choose a source in the middle of the survey. In `Map/3D survey Modes/View Relation` menu command click the selected shot point. The chosen Shot will be highlighted with a red dot, the rest of shot points will be shown as grey dots. Receiver points associated with the chosen source will be colored in blue and the rest receivers will be grey:


map - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
200%
A
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

inline: 63, crossline: 9, [3100.0,1600.0] X=16373.5 Y=22843.5

You can add or remove receivers around this shot point by using `Map/3D survey Modes/Remove Receivers from Shot` and `Map/3D survey Modes/Add Receivers to Shot` commands. These two commands behave similarly to the `Hide/Show` command (click--drag-release).

Example:

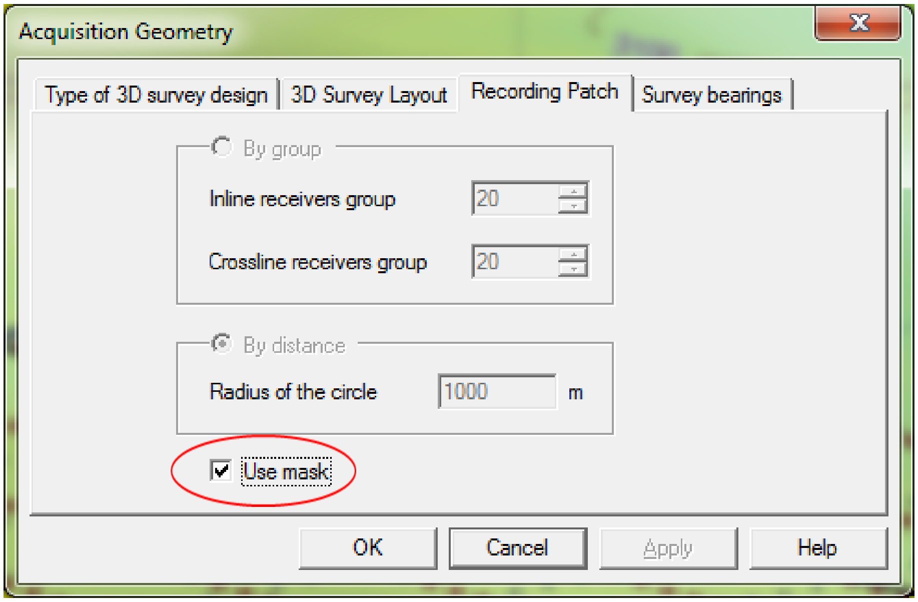

map - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
200%
A
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

inline: 47, crossline: 10, [2300.0,1800.0]

X=18752.8

Y=23021.0

Now you can pick any source in `Map/3D survey Modes/View Relation` and the group of receivers allocated for that source will have identical shape. At the same time the `Acquisition Geometry` dialog in the `Recording Patch` tab the "`Use mask`" checkbox will be automatically enabled:


Acquisition Geometry
Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings
OK
Cancel
Apply
Help

○ By group

Inline receivers group 20

Crossline receivers group 20

● By distance

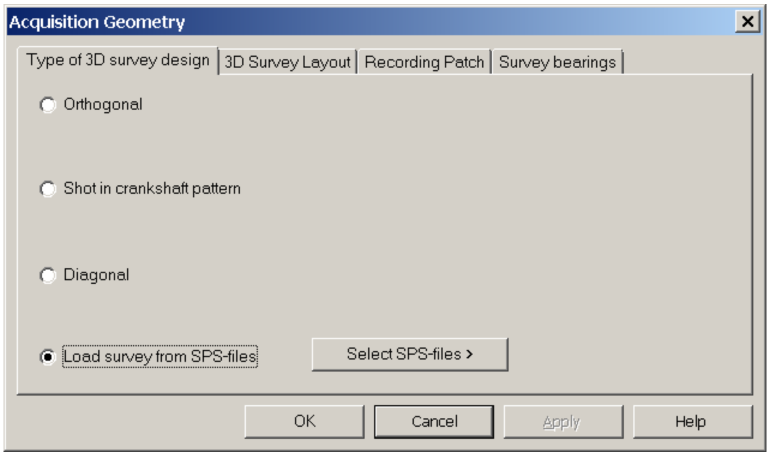
Radius of the circle 1000 m

☑ Use mask

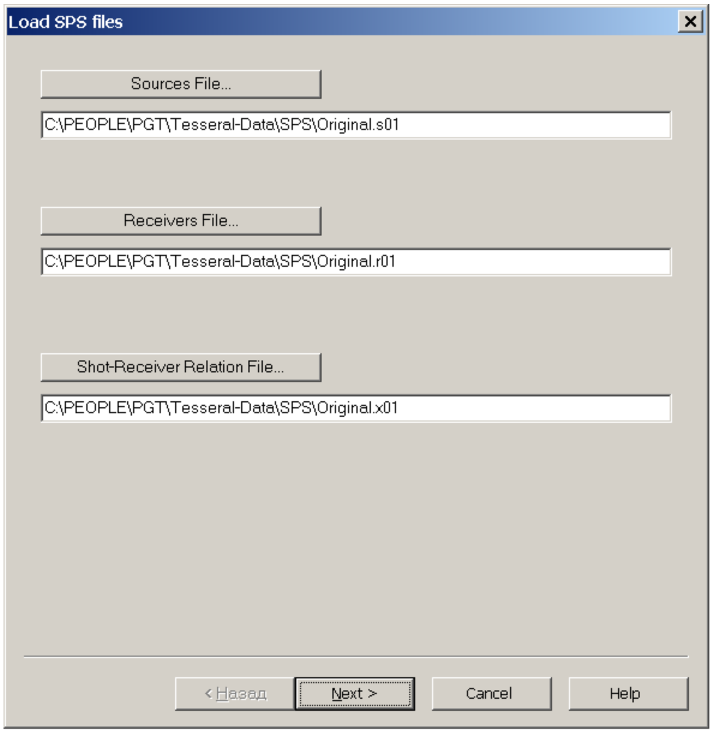
In other words, the receiver patch is specified by the mask which has been shaped manually but not by parameters `Inline (Crossline) receivers group.`

9.1.7 Load survey from SPS-files.

Here is another useful way to create 3D survey using standard SPS-format. You can use the same command `Map/Acquisition Geometry`.


Acquisition Geometry
Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings
○ Orthogonal
○ Shot in crankshaft pattern
○ Diagonal
● Load survey from SPS-files
Select SPS-files >
OK
Cancel
Apply
Help

Select `Load survey from SPS-files` and press the `Select SPS-files>` button.

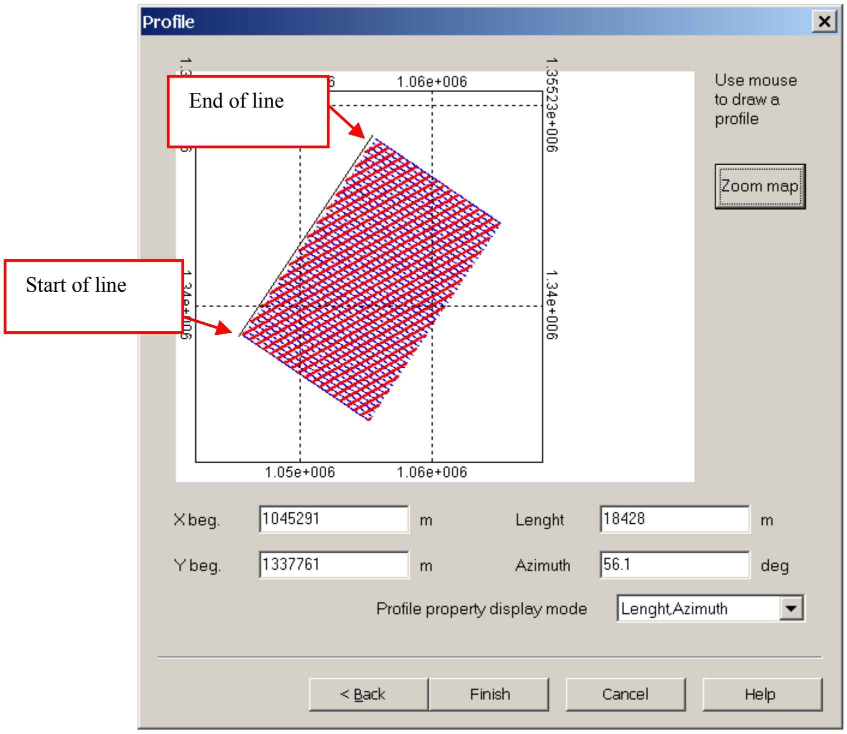

Load SPS files
Sources File...
Receivers File...
Shot-Receiver Relation File...
< Назад
Next >
Cancel
Help

C:\PEOPLE\PGT\Tesseral-Data\SPS\Original.s01

C:\PEOPLE\PGT\Tesseral-Data\SPS\Original.r01

C:\PEOPLE\PGT\Tesseral-Data\SPS\Original.x01

In the next dialog load the SPS-files for shots, receivers and their relation file. Press the button `Next >`. The dialog with the 3D survey loaded from these SPS-files will be displayed.


Profile
End of line
Start of line
1.06e+006
1.35523e+006
1.34e+006
1.05e+006
1.06e+006
Use mouse to draw a profile
Zoom map
< Back
Finish
Cancel
Help

X beg. 1045291 m

Y beg. 1337761 m

Lenght 18428 m

Azimuth 56.1 deg

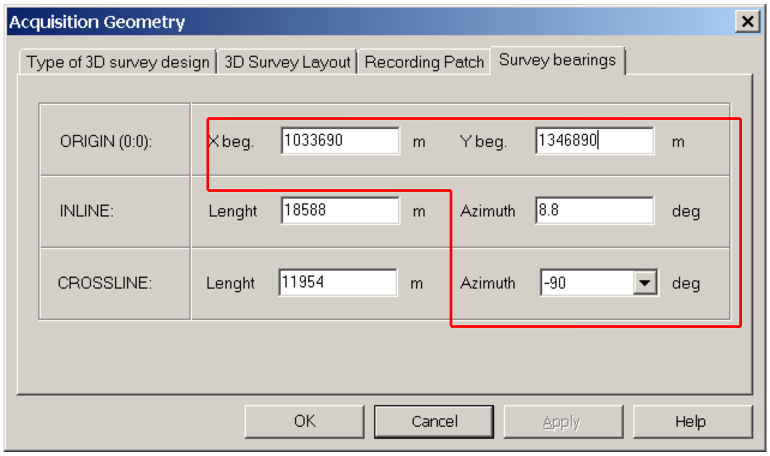
Profile property display mode: Lenght,Azimuth

You need to input coordinates for the ORIGIN point and the INLINE Length and Azimuth in this dialog. This line is needed to make it easier to move and rotate the 3D survey which has been loaded from SPS files. It is recommended to use mouse to draw the line on the map (click--drag-release). You do not have to be precise with line drawing.

You can zoom in this picture by pressing the `Zoom map` button to view it at a bigger scale.

As soon as you finish loading the SPS-files, you will be prompted to `Acquisition Geometry` dialog.

The `3D survey Layout` and `Recording Patch` tabs will not be used when you proceed with the `Load survey from SPS-files` option. In the `Survey bearings` tab the dimension parameters will be ignored but the 3D survey geographical parameters are necessary:

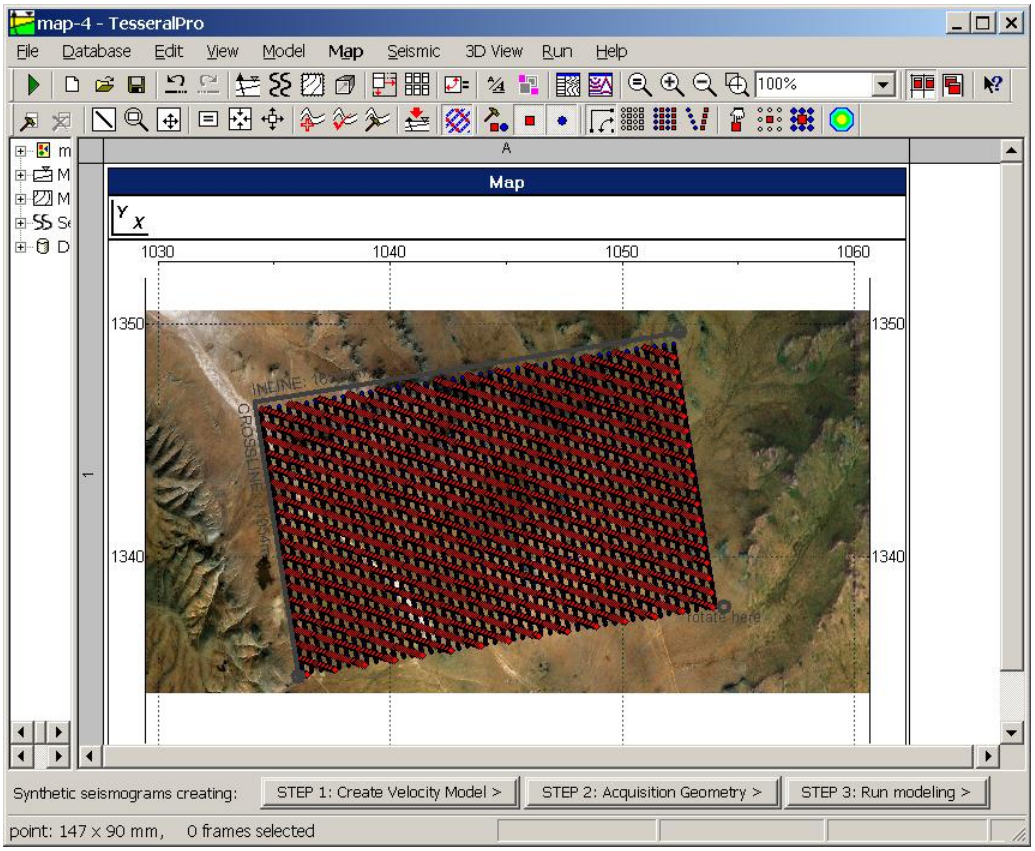

Acquisition Geometry
Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings
OK
Cancel
Apply
Help

ORIGIN (0:0): X beg. 1033690 m Y beg. 1346890 m

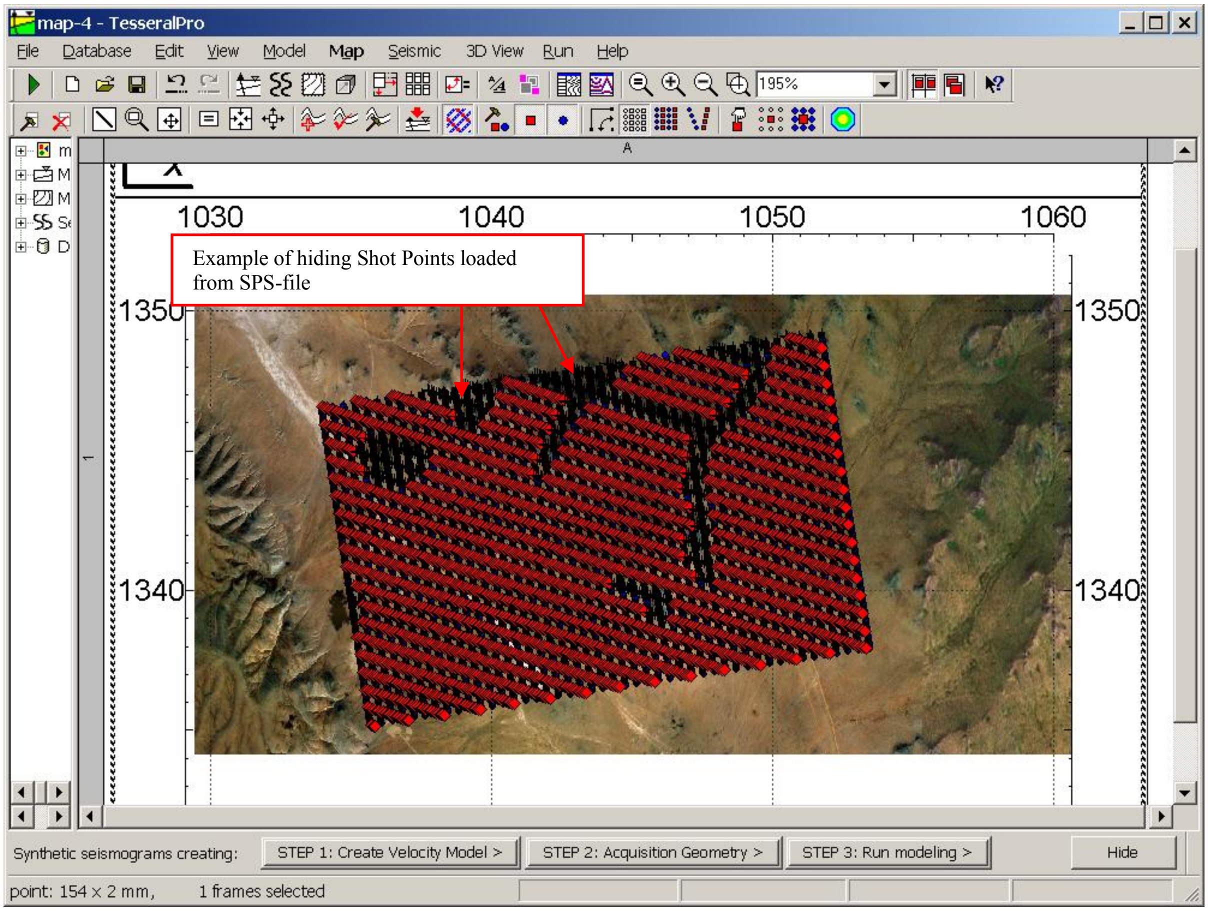
INLINE: Lenght 18588 m Azimuth 8.8 deg

CROSSLINE: Lenght 11954 m Azimuth -90 deg

Result:


map-4 - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Map
Y
X
1030
1040
1050
1060
1350
1340
INLINE:
CROSSLINE
rotate here
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
point: 147 x 90 mm, 0 frames selected

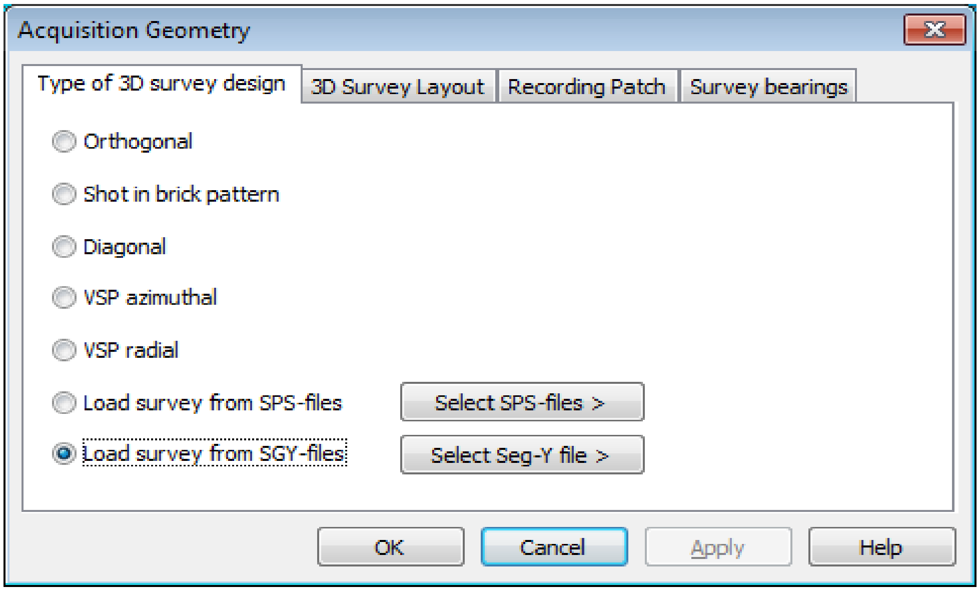
You can edit survey loaded from SPS-files using the commands `Moving with rotation`, `Hide`, `Show`:


map-4 - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
195%
1030
1040
1050
1060
1350
1340
1350
1340
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 154 x 2 mm,
1 frames selected

Example of hiding Shot Points loaded from SPS-file

9.1.8 Load survey from SGY-files.

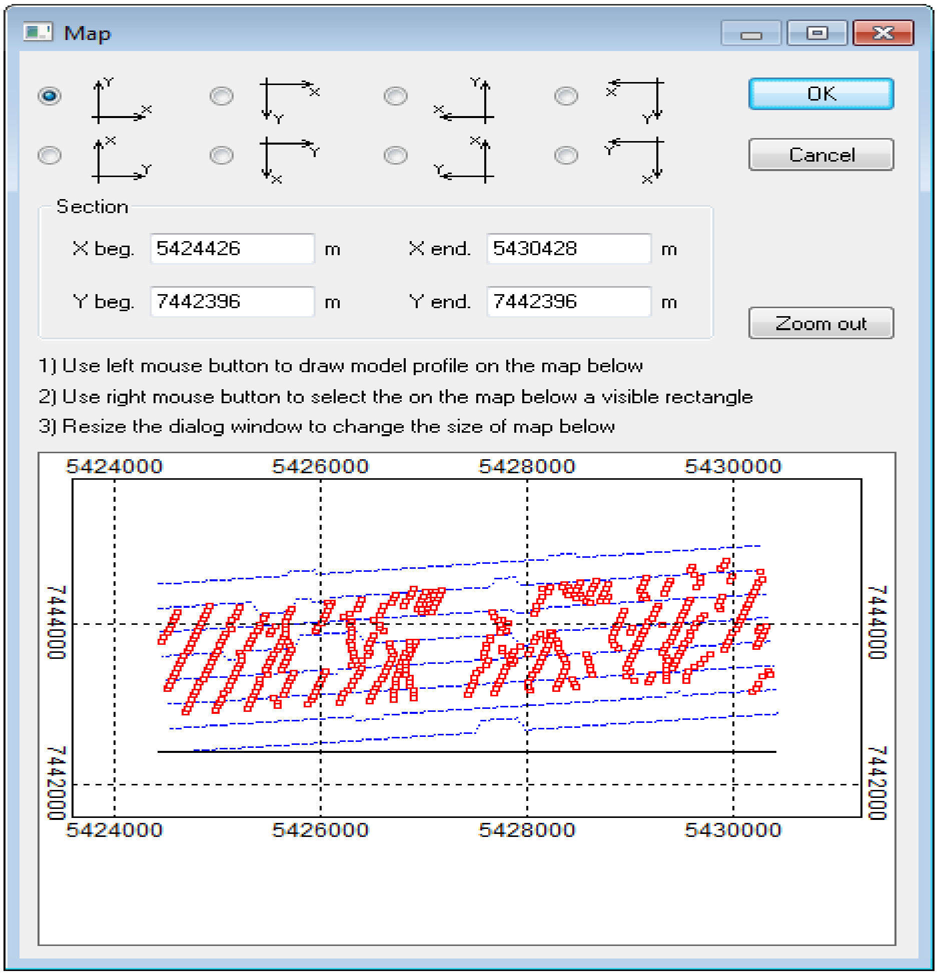
There is also the option of loading the seismic survey from synthetic seismogram in SGY format.


Acquisition Geometry
Type of 3D survey design
3D Survey Layout
Recording Patch
Survey bearings
○ Orthogonal
○ Shot in brick pattern
○ Diagonal
○ VSP azimuthal
○ VSP radial
○ Load survey from SPS-files
Select SPS-files >
Select Seg-Y file >
OK
Cancel
Apply
Help

● Load survey from SGY-files

Select `Load survey from SGY-files` and press the `Select SGY-files>`

button.



Map
OK
Cancel
Zoom out
Section
5424000
5426000
5428000
5430000
7444000
7442000

X beg. 5424426 m

X end. 5430428 m

Y beg. 7442396 m

Y end. 7442396 m

1) Use left mouse button to draw model profile on the map below

2) Use right mouse button to select the on the map below a visible rectangle

3) Resize the dialog window to change the size of map below

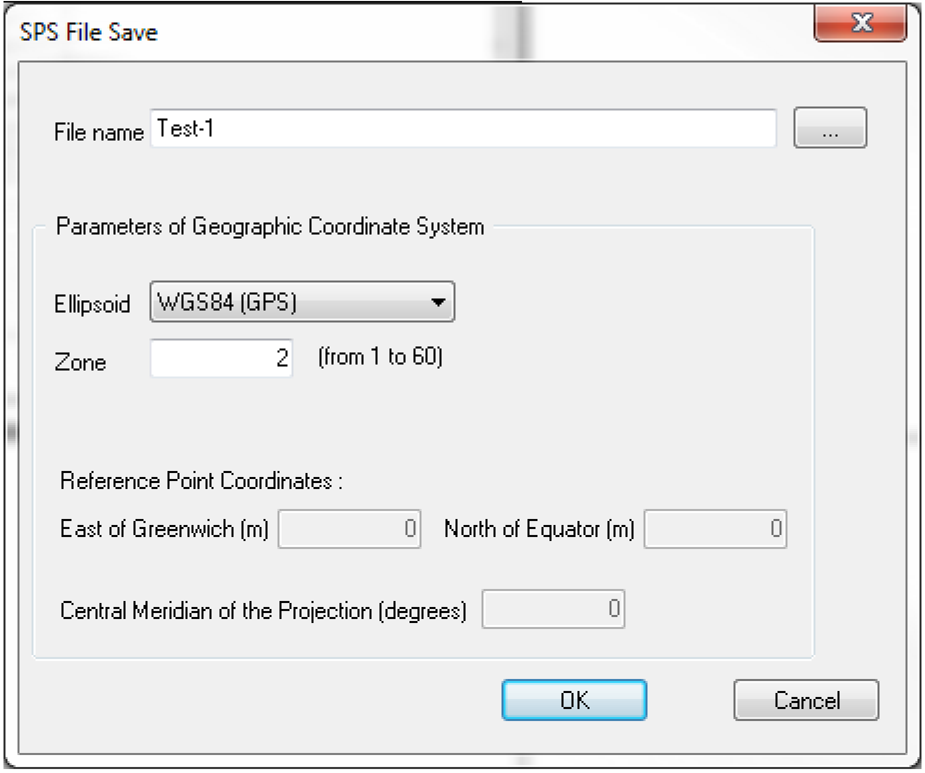
9.1.9 3D survey export to SPS-files.

The 3D survey created in the Map frame can be exported into standard SPS format. To do this, please use the `Map/Export to SPS` menu command. Select a source file name, and the receiver and relation files will be created automatically. As the result you will have three SPS files:

S01 – source;
R01 – receivers;
X01 – relation file.

9.1.10 3D survey export to KML-file.

The 3D survey created in the Map frame can be exported into standard KML format, which is the format used for displaying objects used by Google Maps. To do this, please use the `Map/Export 3D Survey to KML` menu command.



SPS File Save

File name: Test-1

Parameters of Geographic Coordinate System

Ellipsoid: WGS84 (GPS)

Zone: 2 (from 1 to 60)

Reference Point Coordinates :

East of Greenwich (m): 0

North of Equator (m): 0

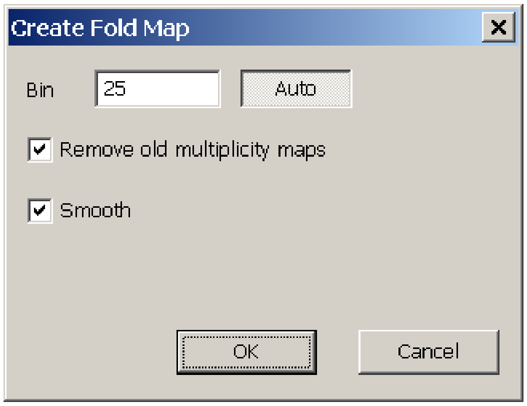
Central Meridian of the Projection (degrees): 0

Choose a name for the output KML files, the reference `Ellipsoid`, as well as the zone number. As the result 2 KML files will be generated:

Sources.kmz
Receivers.kmz;

9.1.11 Fold Map

Choose the menu command <u>`Map/Fold Map/Create Fold Map`</u>



Create Fold Map

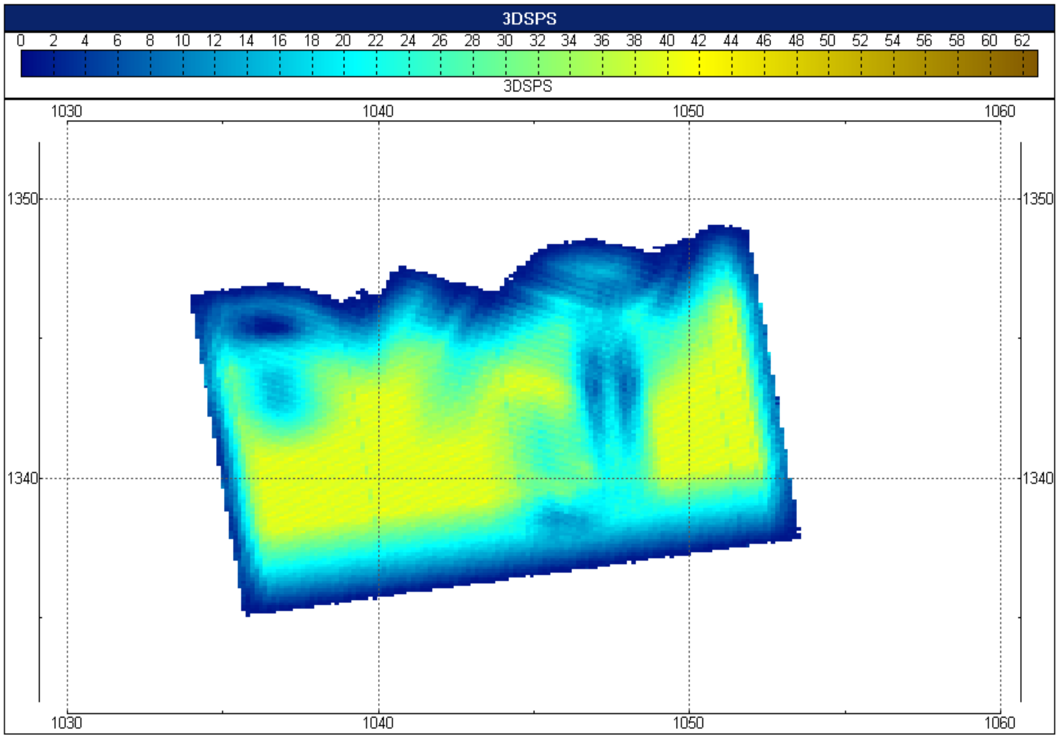
Bin 25

☑ Remove old multiplicity maps

☑ Smooth

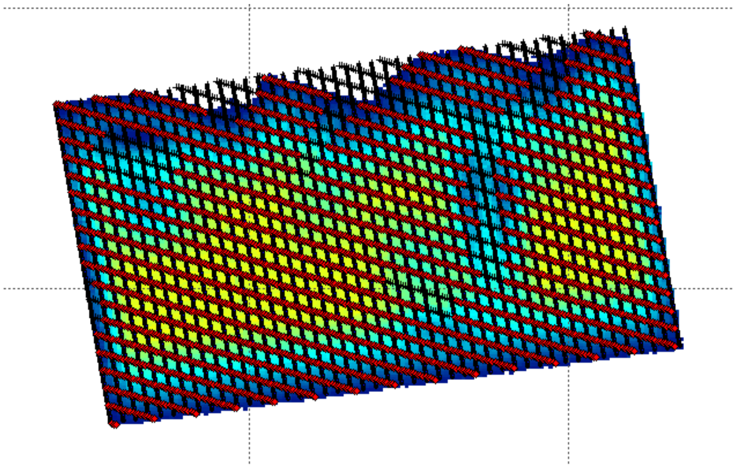
Auto
OK
Cancel

Fold Map:

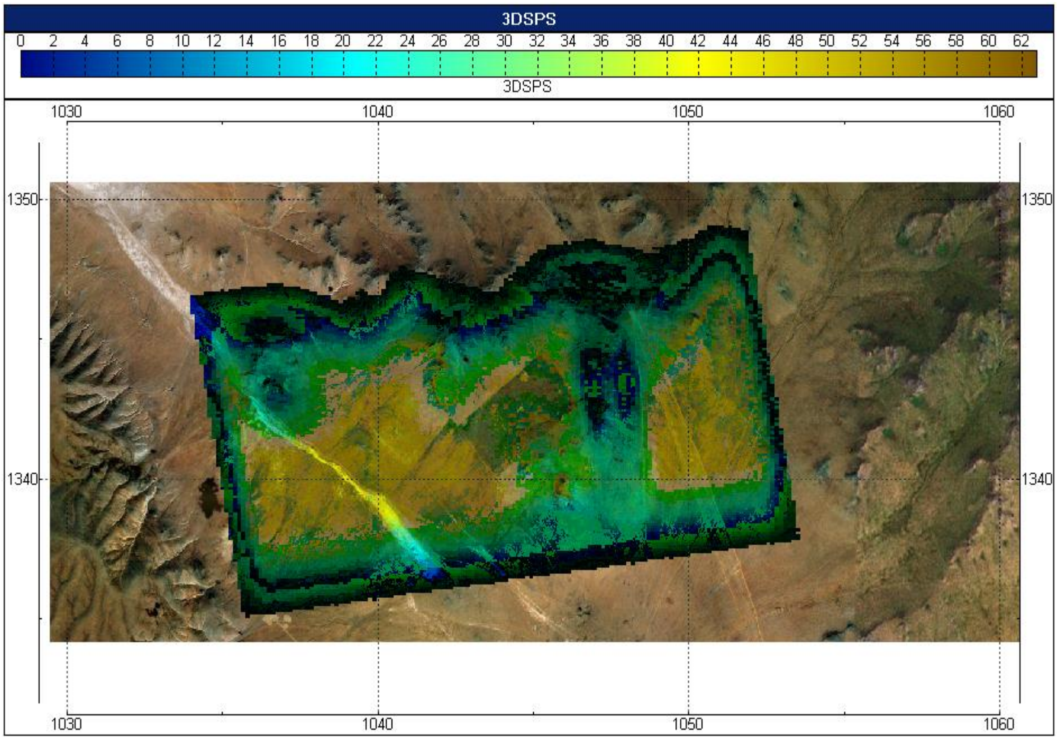


3DSPS
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62
3DSPS
1030
1040
1050
1060
1350
1340

Fold Map over-layered by Shot and Receiver Lines:



Fold Map over-layered on background picture:

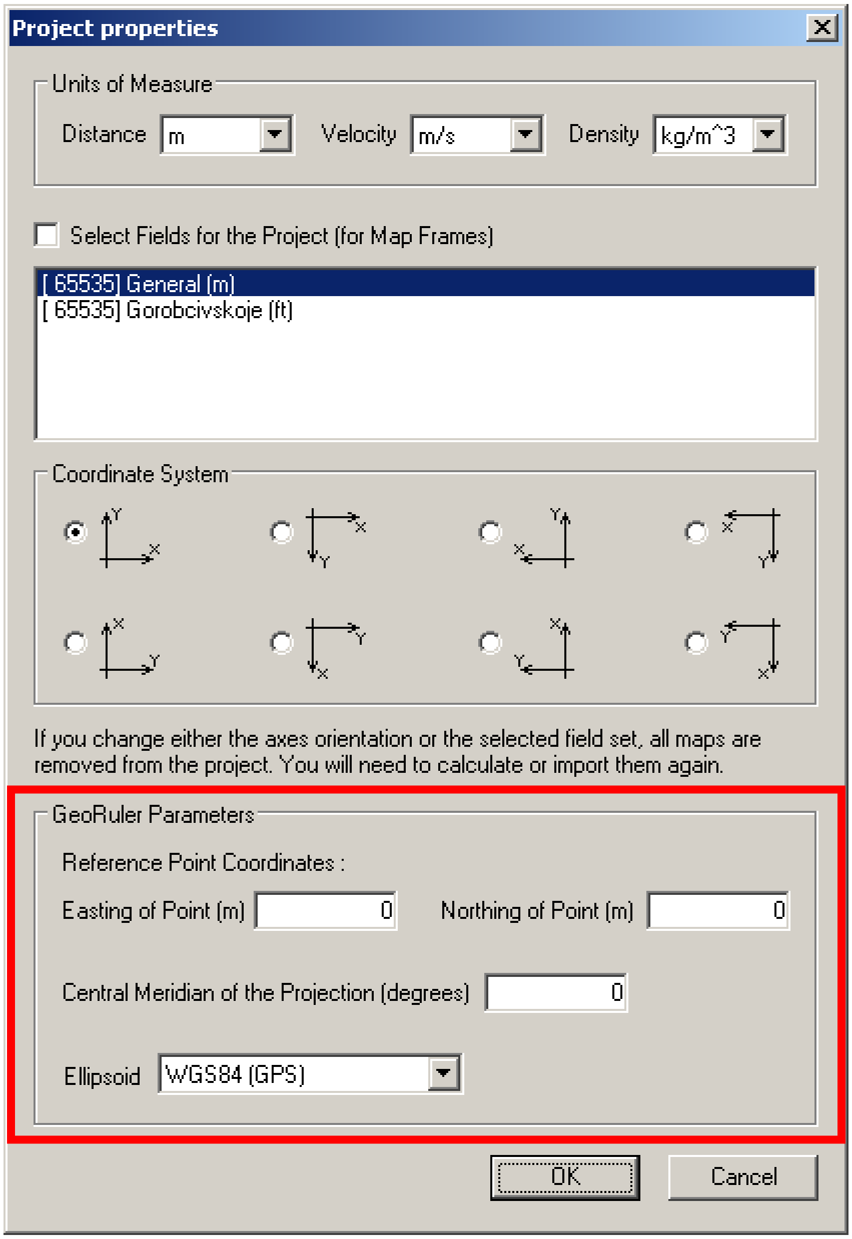

3DSPS
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62
3DSPS
1030
1040
1050
1060
1350
1340

For hiding, showing or recalculating the Fold Map using different bin sizes choose the command `Map/Fold Map/Show Fold Map`.

9.1.12 Coordinate Reference Systems Options

Please note that multiple coordinate reference systems are available in the frame `Map`, and they are based on the following ellipsoids: WGS-84 (GPS), NAD-83 (GRS), NAD-27 (Clarke 1866), ETRS-89, SK-42 (Krasovsky), PZ-90 (GLONASS), GSK-2011.

In order for the chosen reference coordinate system to be displayed, it is necessary in the `Map>Map Frame Properties>Project properties…` to set non-zero coordinates for `Easting` and `Northing of Point` (i.e. upper right hand corner of the map) for the chosen `Ellipsoid`. And also to set a value for the `Central Meridian of the Projection (degrees)` of the ellipsoid, which is conventionally set to zero.



Distance: m
Velocity: m/s
Density: kg/m^3

☐ Select Fields for the Project (for Map Frames)

[65535] General (m)
[65535] Gorobcivskoje (ft)

If you change either the axes orientation or the selected field set, all maps are removed from the project. You will need to calculate or import them again.

Reference Point Coordinates :
Easting of Point (m): 0
Northing of Point (m): 0
Central Meridian of the Projection (degrees): 0
Ellipsoid: WGS84 (GPS)

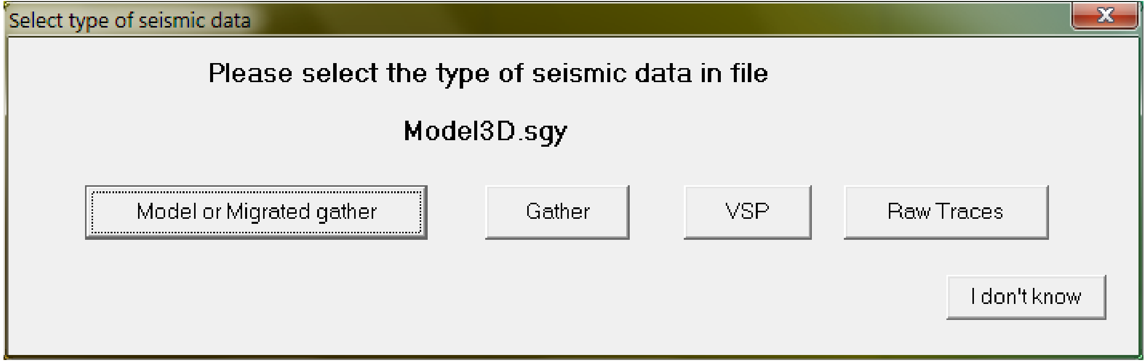
9.2 3D Ray Tracing Modeling

To simulate 3D Ray tracing in Tesseral Pro, you need to create a 3D model consisting of a 3D velocity Model in Seg-Y format (see ***9.13.4***), a reflecting surface in one of the standard grid formats (see ***14.1***) and create a 3D survey layout (see ***9.1***).

9.2.1 Previewing 3D Velocity Model

In order to preview the 3D velocity model as a SEG-Y file, the user can load it into the Seismic Frame (see Section *13*) and then display it in 3D View Frame (see Section *15*).

To load the 3D SEG-Y file, choose one of the `File > Load Seismic File` or `Seismic > Load Seismic File (New Frame)` menu commands. Select the file in the standard File Open dialog box, and in the dialog

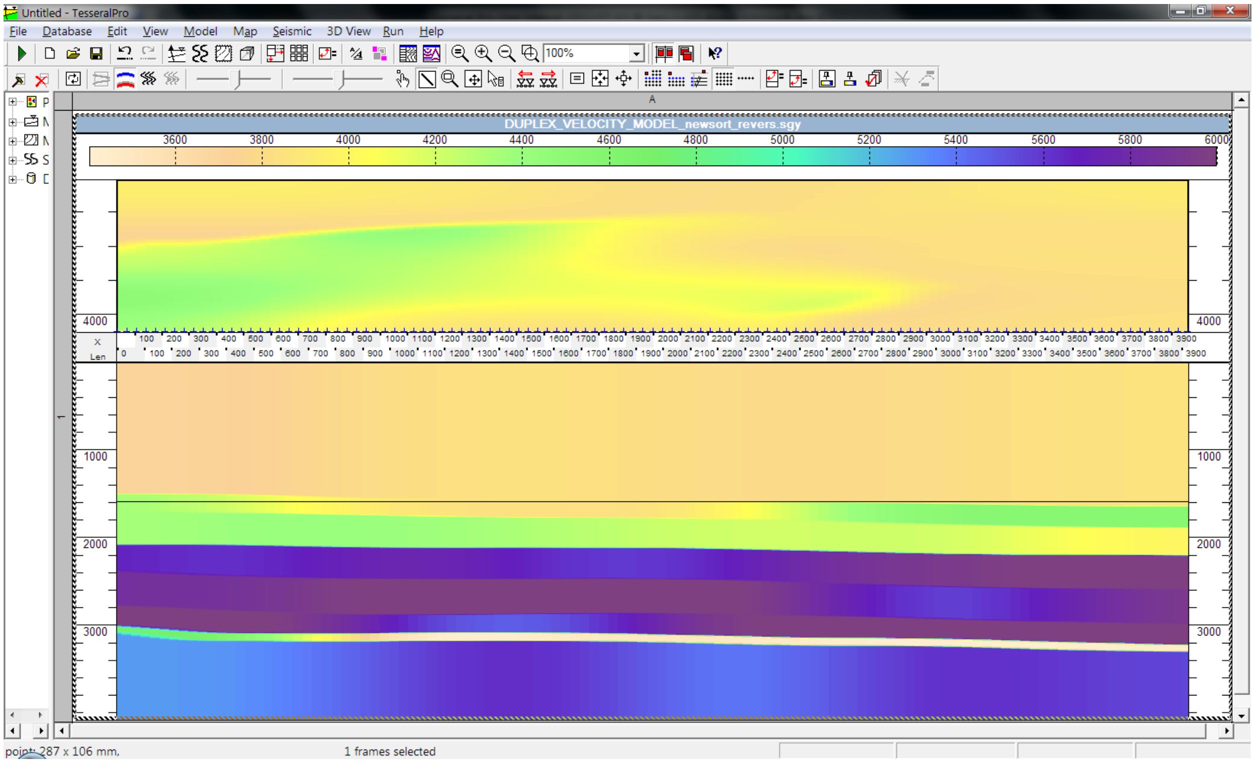

Select type of seismic data
Model or Migrated gather
Gather
VSP
Raw Traces
I don't know

Please select the type of seismic data in file

Model3D.sgy

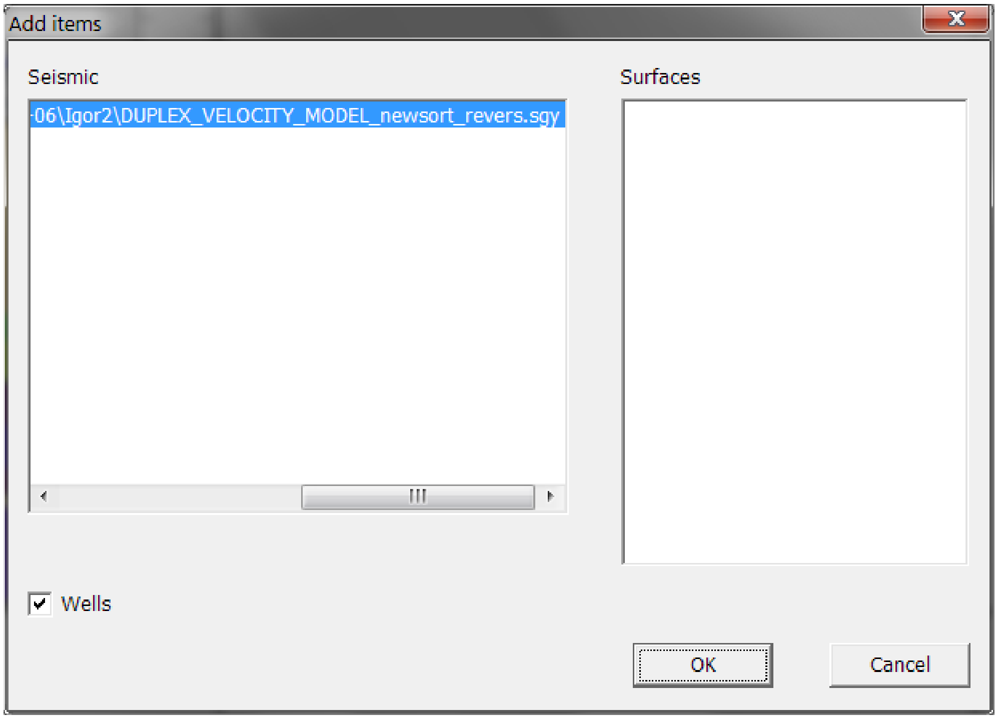
choose 'Model or Migrated gather'. Your choice is remembered and next time you load the same file, you will not be asked.

The file will open in the new Seismic Frame.


Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
DUPLEX_VELOCITY_MODEL_newsort_revers.sgy
3600
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
6000
4000
1000
2000
3000
point: 287 x 106 mm,
1 frames selected

More details on managing and displaying 3D Model files can be found in Section *9.13.4*

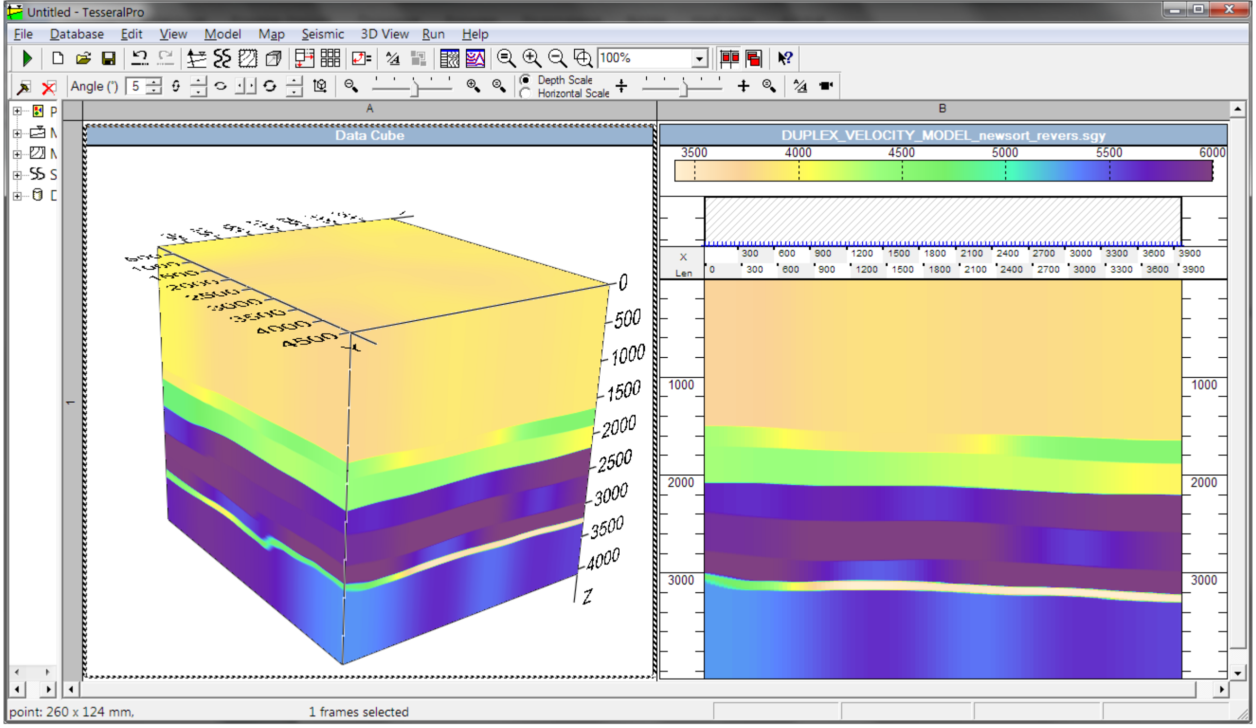
You can also display the same 3D Model file in 3D view. To do this, create a new 3D View Frame by the `3D View > View Data Cube (New Frame)` menu command. In the Add Items dialog box, select the file you want to view:


Add items
Surfaces
OK
Cancel

Seismic: -06\Igor2\DUPLEX_VELOCITY_MODEL_newsort_revers.sgy

☑ Wells

Then the 3D Velocity model is displayed in the 3D View:


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Angle (°) 5
Depth Scale
Horizontal Scale
A
B
Data Cube
DUPLEX_VELOCITY_MODEL_newsort_revers.sgy
3500 4000 4500 5000 5500 6000
0 500 1000 1500 2000 2500 3000 3500 4000 Z
1000
2000
3000
point: 260 x 124 mm,
1 frames selected

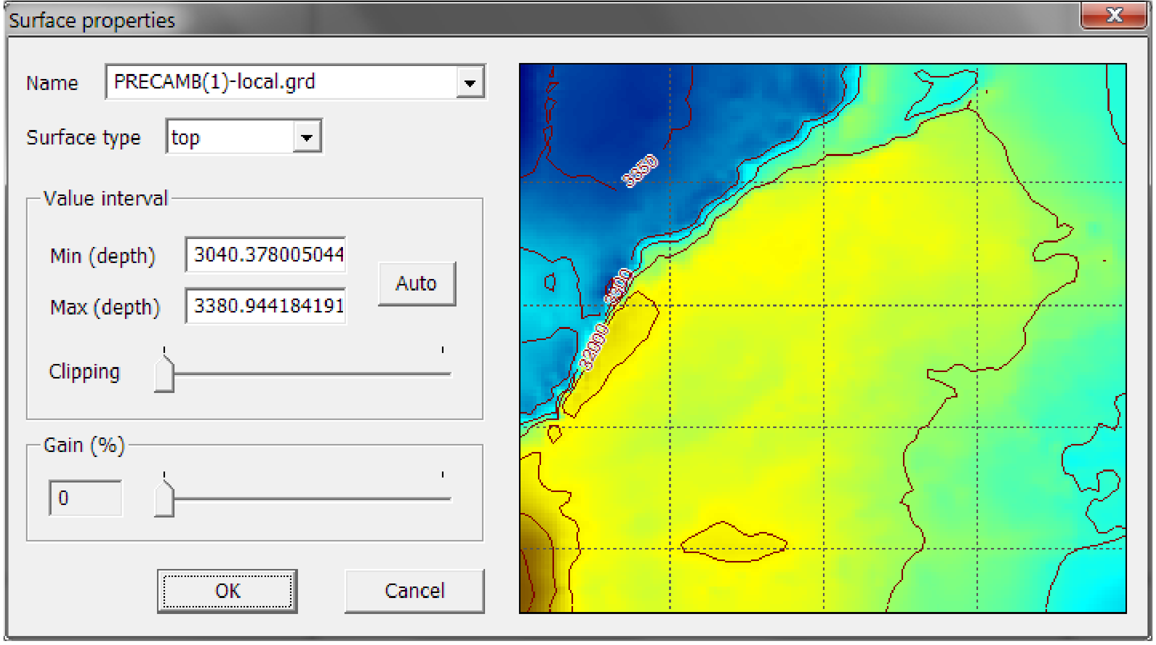
See Section *15* for details on 3D View options.

NOTE: It is not necessary for 3D ray tracing procedure to have the 3D velocity file loaded into the interface. But this step is useful for previewing the file and making sure you choose the right file for the simulation.

9.2.2 Loading the Reflecting Surface

The reflecting surface can be in any of the standard grid formats (see *14.1*). To load it, choose the `File > Load Surface File` menu command. If a Map Frame is not created, it will be created and the file loaded. Alternatively, you can use the menu `Map > Create Map (New Frame)` and in the dialog box select "Load TXT or GRD-surface files".

When loading surface, you will be asked about creating isolines. This is only for display and is optional. After that, you will be presented with the Surface properties dialog:


Surface properties

Name: PRECAMB(1)-local.grd

Surface type: top

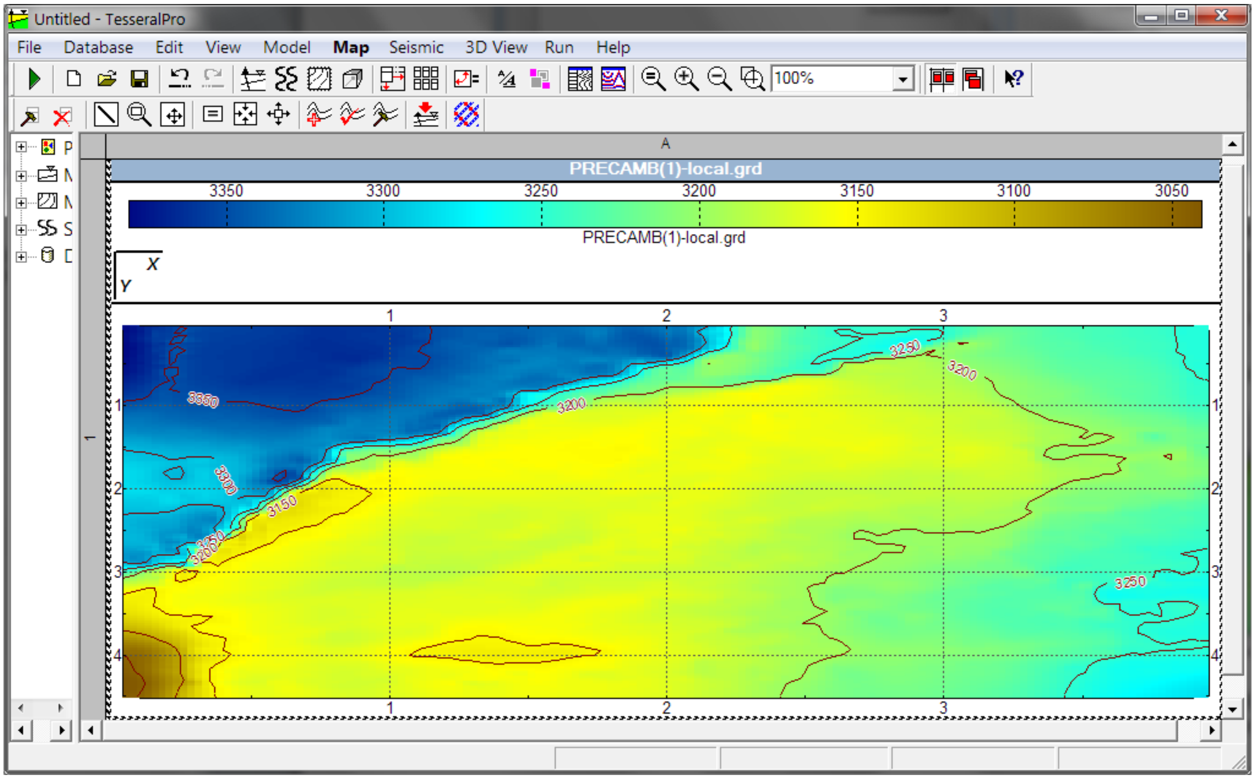
Value interval

Min (depth): 3040.378005044

Max (depth): 3380.944184191

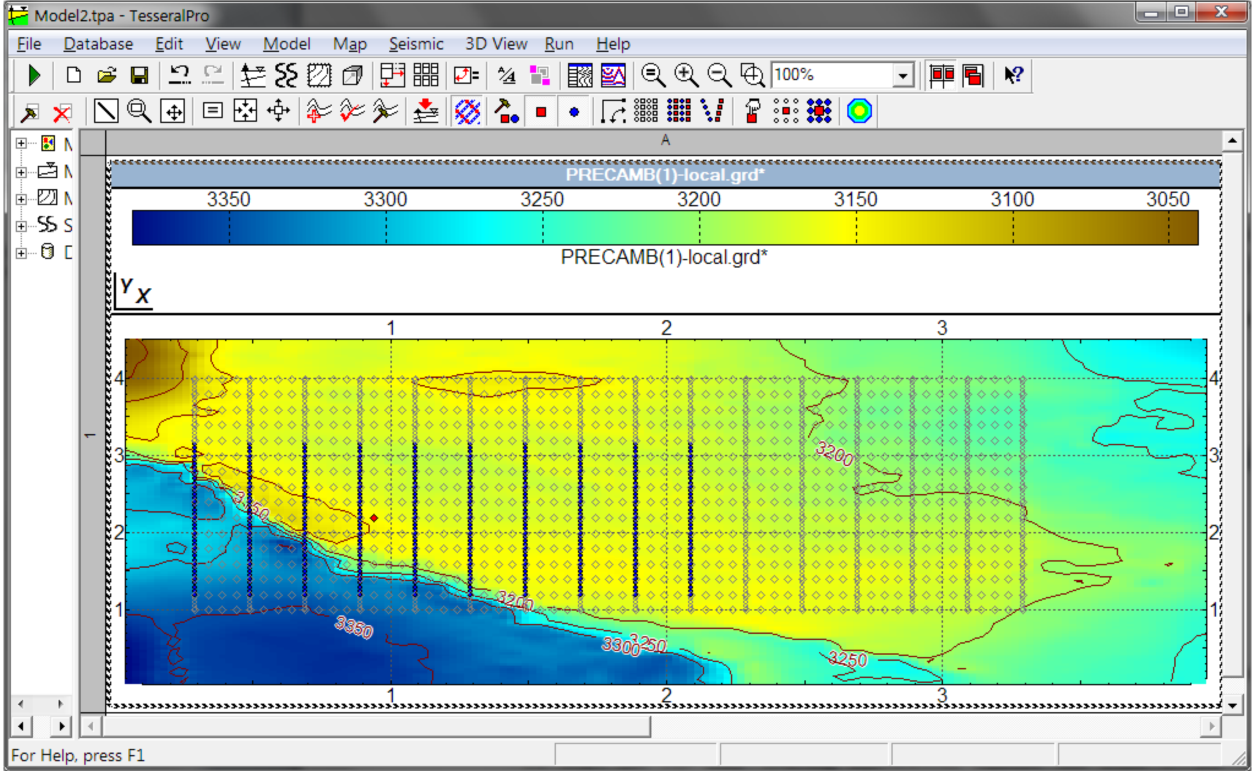
Gain (%): 0

More details on the options in this dialog and on working with the Map Frame can be found in Section *14*. After you click OK, the surface is loaded into the Map Frame

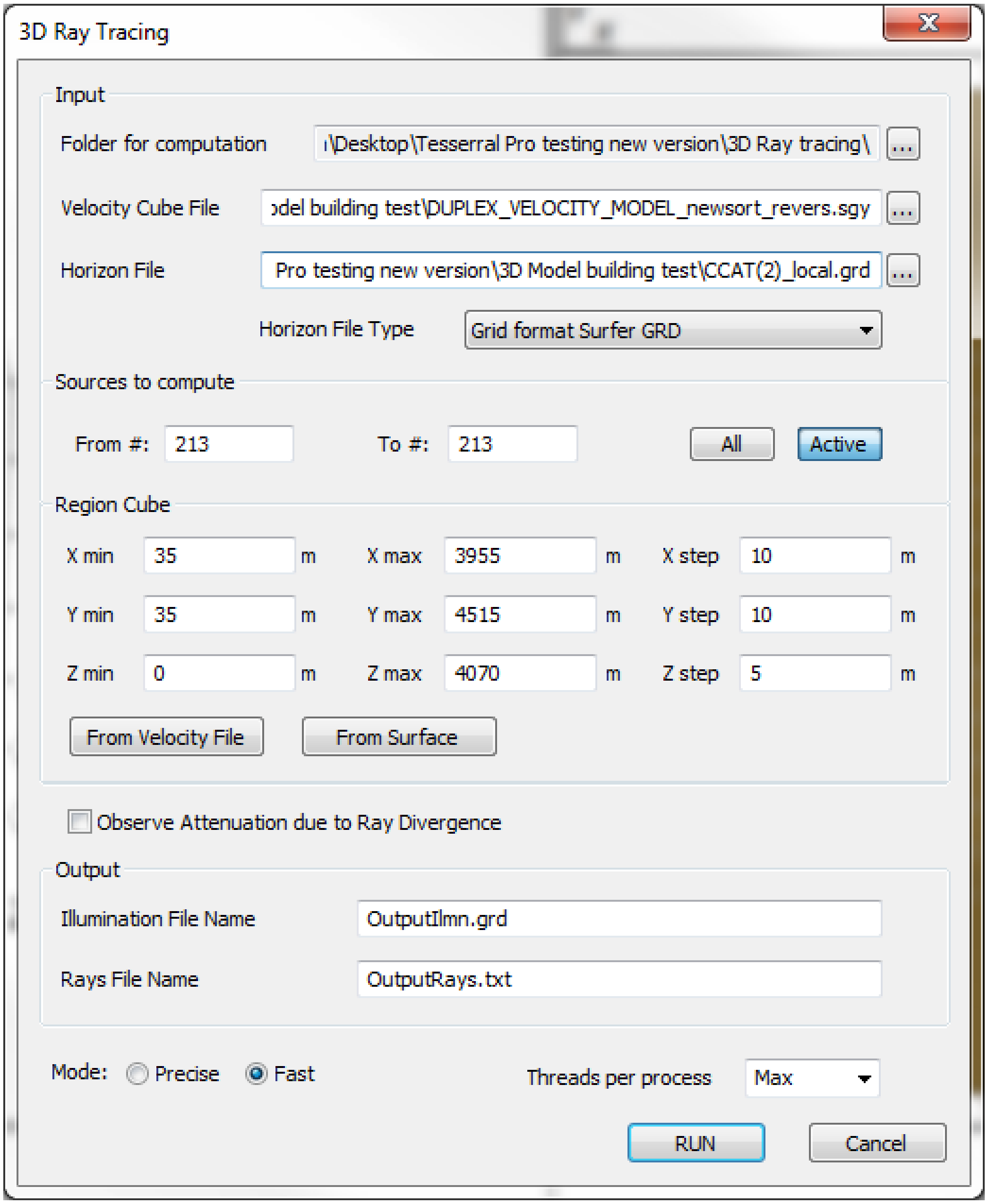

Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
A
PRECAMB(1)-local.grd
3350
3300
3250
3200
3150
3100
3050
PRECAMB(1)-local.grd
X
Y
1
2
3
3350
3300
3200
3150
3250
3200
3250

9.2.3 3D Ray Tracing simulation

Before you start the simulation, you need to create the 3D survey layout (see Section *9.1*). Here is an example of a reflection surface and a 3D survey layout.


Model2.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
PRECAMB(1)-local.grd*
3350
3300
3250
3200
3150
3100
3050
PRECAMB(1)-local.grd*
Y
X
1
2
3
4
3200
3350
3300
3250
For Help, press F1

To start the 3D Ray Tracing simulation, choose the `Run > 3D Ray Tracing Modeling…` menu command. If you have not saved the project, you will be prompted to do so. After that, the 3D Ray Tracing dialog box opens:



3D Ray Tracing

Input

Folder for computation: \Desktop\Tesserral Pro testing new version\3D Ray tracing\

Velocity Cube File: del building test\DUPLEX_VELOCITY_MODEL_newsort_revers.sgy

Horizon File: Pro testing new version\3D Model building test\CCAT(2)_local.grd

Horizon File Type: Grid format Surfer GRD

Sources to compute

From #: 213 To #: 213

Region Cube

X min	35	m	X max	3955	m	X step	10	m
Y min	35	m	Y max	4515	m	Y step	10	m
Z min	0	m	Z max	4070	m	Z step	5	m

☐ Observe Attenuation due to Ray Divergence

Output

Illumination File Name: OutputIlmn.grd

Rays File Name: OutputRays.txt

Mode: ○ Precise ● Fast

Threads per process: Max

You can change the following options:

- Folder for computation. Specifies the folder where the input files and the computation results are stored.
- Velocity Cube File. Specifies the 3D velocity SEG-Y file used for the 3D Model (see *9.2.1*)
- Surface File. Specifies the reflection surface file (see *9.2.2*)
- Surface File Type. Specifies the file type used for the reflection surface. See details in *14.1*
- Sources to compute group. Specify the range of sources to compute. Input the range into the edit fields or click the button All to compute all sources, or Active to compute only the active selected source in the 3D survey layout (see *9.1*)
- Region Cube group. Specify the 3D Model region for computation or use the button From Velocity File or From Surface to set the region based on the

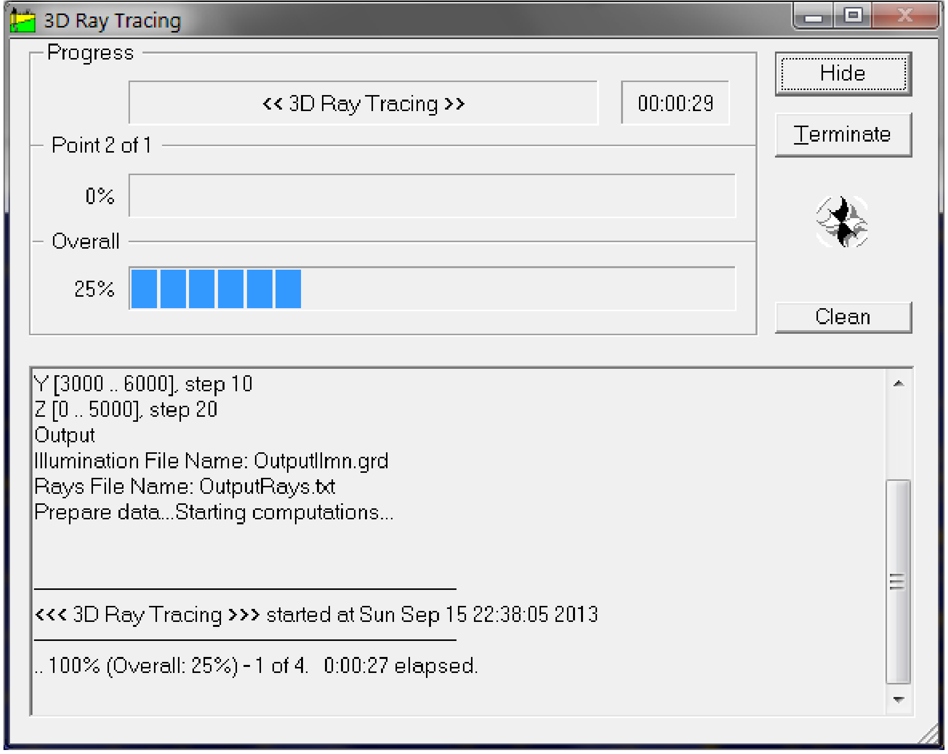
corresponding ranges in the files.

Also in this group, specify the computation steps. The X step and Y step determine the spatial density of rays during the computation, while the Z step determines the internally used time step and influences the number of links each ray contains.

NOTE: Do not set unnecessarily small values into the step boxes; doing so will significantly increase the computation time.

- Illumination File Name specifies the name of the surface file where the illumination map will be saved after the computation.
- Rays File Name specifies the name of the file (or group of files) where the rays from the sources reaching the receiver will be saved after the computation. The file name will be automatically amended with the source index, and one file will be created for each source in the 3D survey layout.
- The user can also choose to take into account the Attenuation due to Ray divergence and select between 2 modes of computation Fast and Precise.

Click RUN, and the simulation will start. The usual Computation dialog is displayed.



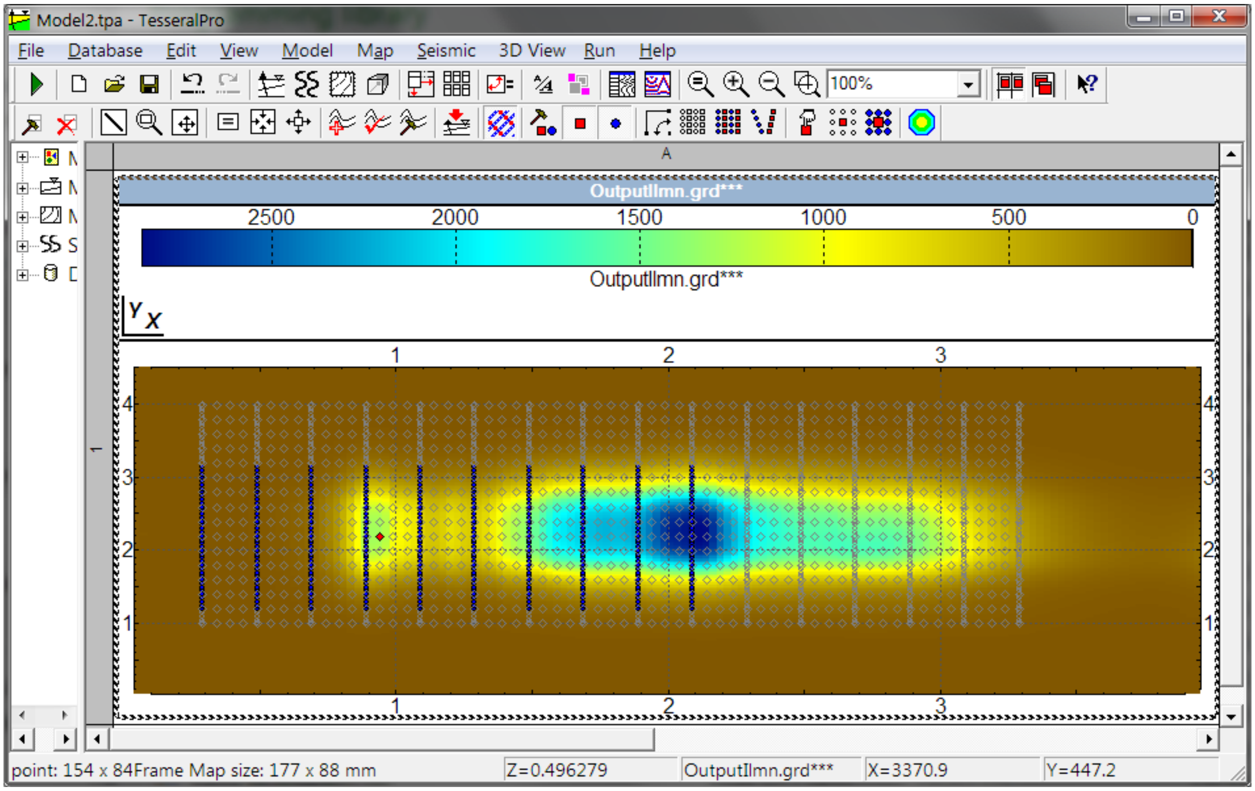
```
Y [3000 .. 6000], step 10
Z [0 .. 5000], step 20
Output
Illumination File Name: OutputIlmn.grd
Rays File Name: OutputRays.txt
Prepare data...Starting computations...

<<< 3D Ray Tracing >>> started at Sun Sep 15 22:38:05 2013

.. 100% (Overall: 25%) - 1 of 4.  0:00:27 elapsed.
```

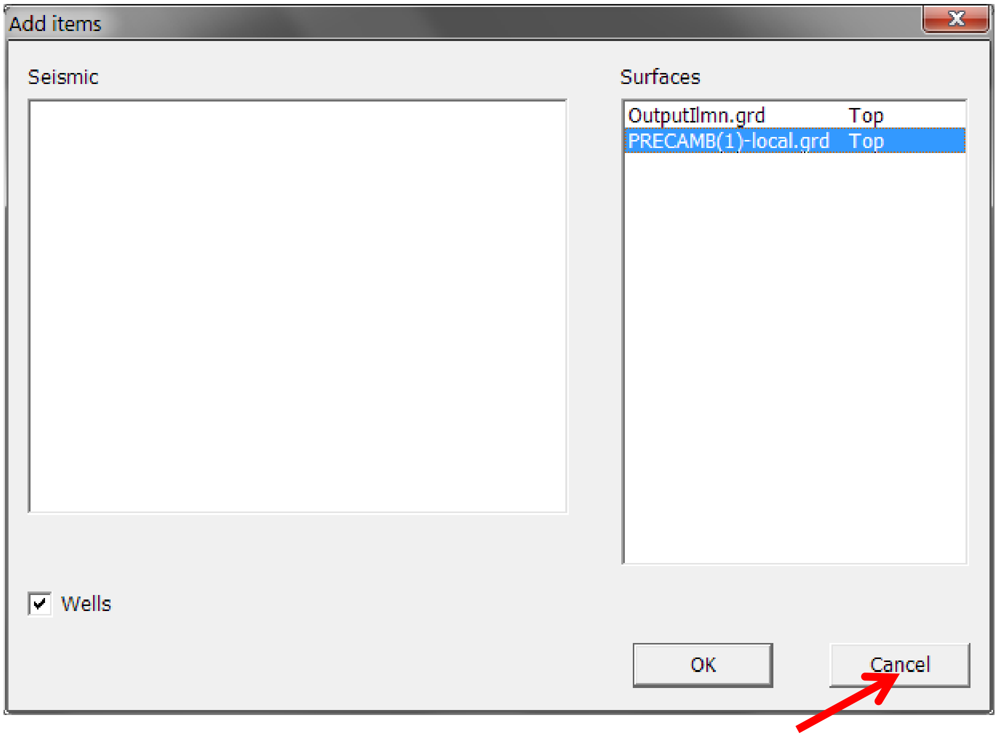
9.2.4 Viewing the Illumination map

After the computation finishes, the resulting illumination file is loaded into the Map Frame. (You are prompted to generate isolines, this is optional).


Model2.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
OutputIlmn.grd***
2500
2000
1500
1000
500
0
OutputIlmn.grd***
Y
X
1
2
3
4
3
2
1
point: 154 x 84Frame Map size: 177 x 88 mm
Z=0.496279
OutputIlmn.grd***
X=3370.9
Y=447.2

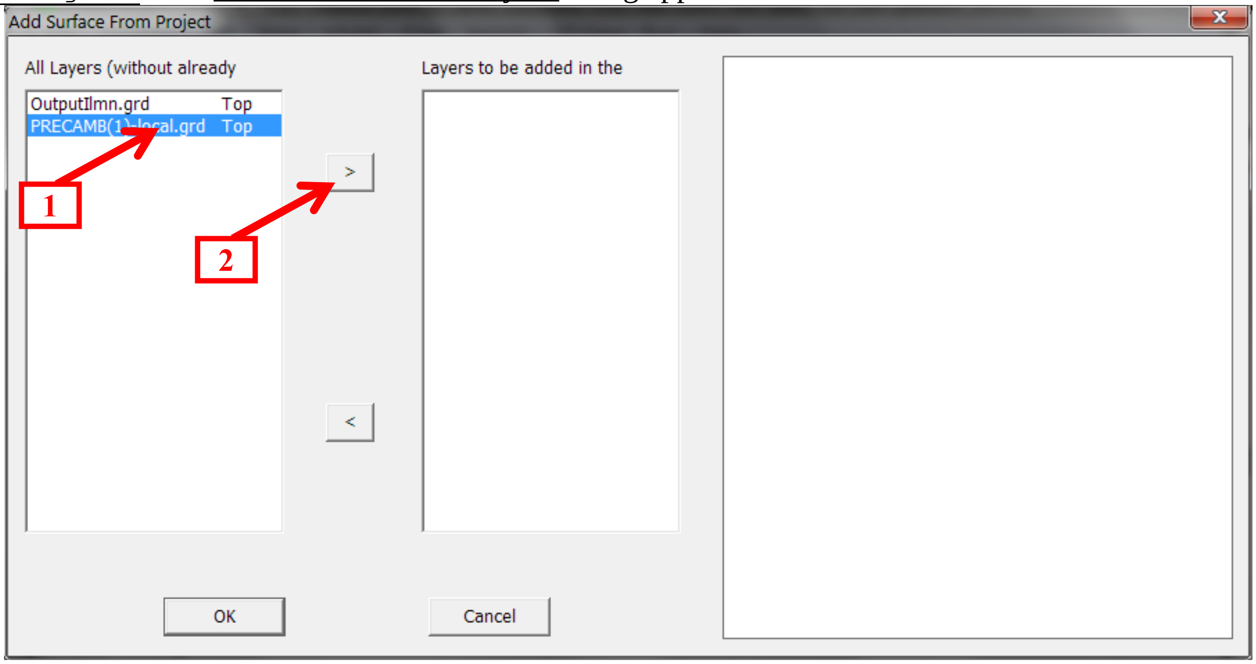
You can load the illumination map at a later time using the `File > Load Surface file` menu command. The file is located in the folder specified in the 3D Ray Tracing dialog (see 9.2.3).

Now you can display the reflection surface filled with the illumination map in the 3D View Frame. To do this, choose the menu command `3D View > View Data Cube (New Frame)`. The Add items dialog box appears:

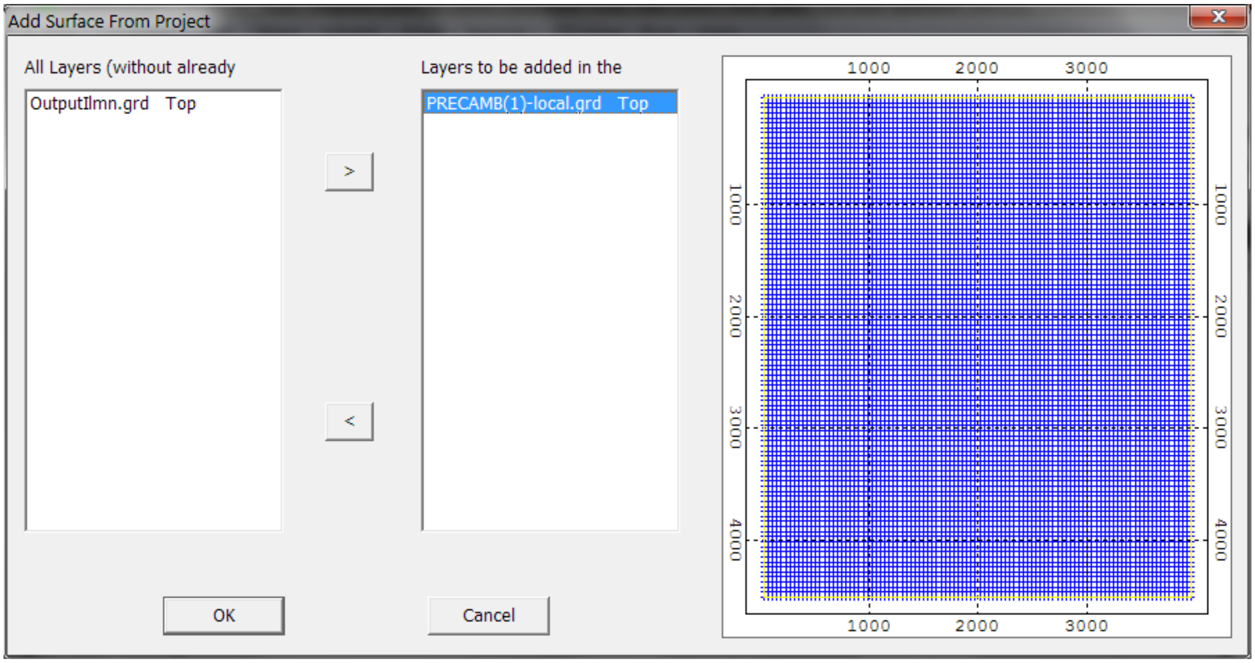

Add items
Seismic
Surfaces
OutputIlmn.grd Top
PRECAMB(1)-local.grd Top
☑ Wells
OK
Cancel

Cancel out of this dialog at this time (do **not** click OK).

The empty 3D View Frame is created. Now choose `3D View > Add Surface > From Project`. The Add Surface From Project dialog appears:


Add Surface From Project
All Layers (without already
Layers to be added in the
OutputIlmn.grd Top
PRECAMB(1)-local.grd Top
1
2
>
<
OK
Cancel

In the left list (All Layers) select the reflection surface and click '>'. The Surface name will be moved to the next list, Layers to be added.



Add Surface From Project

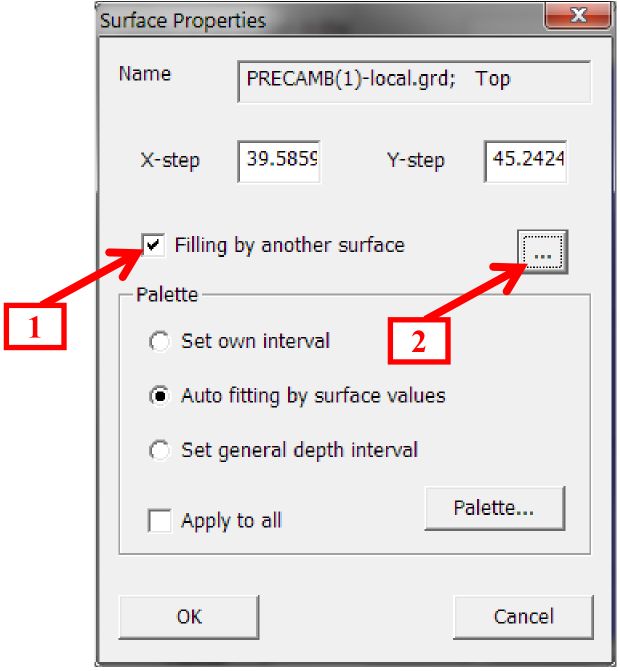
All Layers (without already

OutputIlmn.grd Top

Layers to be added in the

PRECAMB(1)-local.grd Top

Click OK. In the Surface Properties dialog



Surface Properties

Name PRECAMB(1)-local.grd; Top

X-step 39.5859 Y-step 45.2424

☑ Filling by another surface

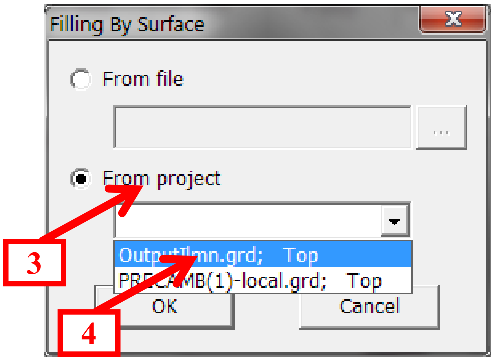
Palette

○ Set own interval

● Auto fitting by surface values

○ Set general depth interval

☐ Apply to all



Filling By Surface

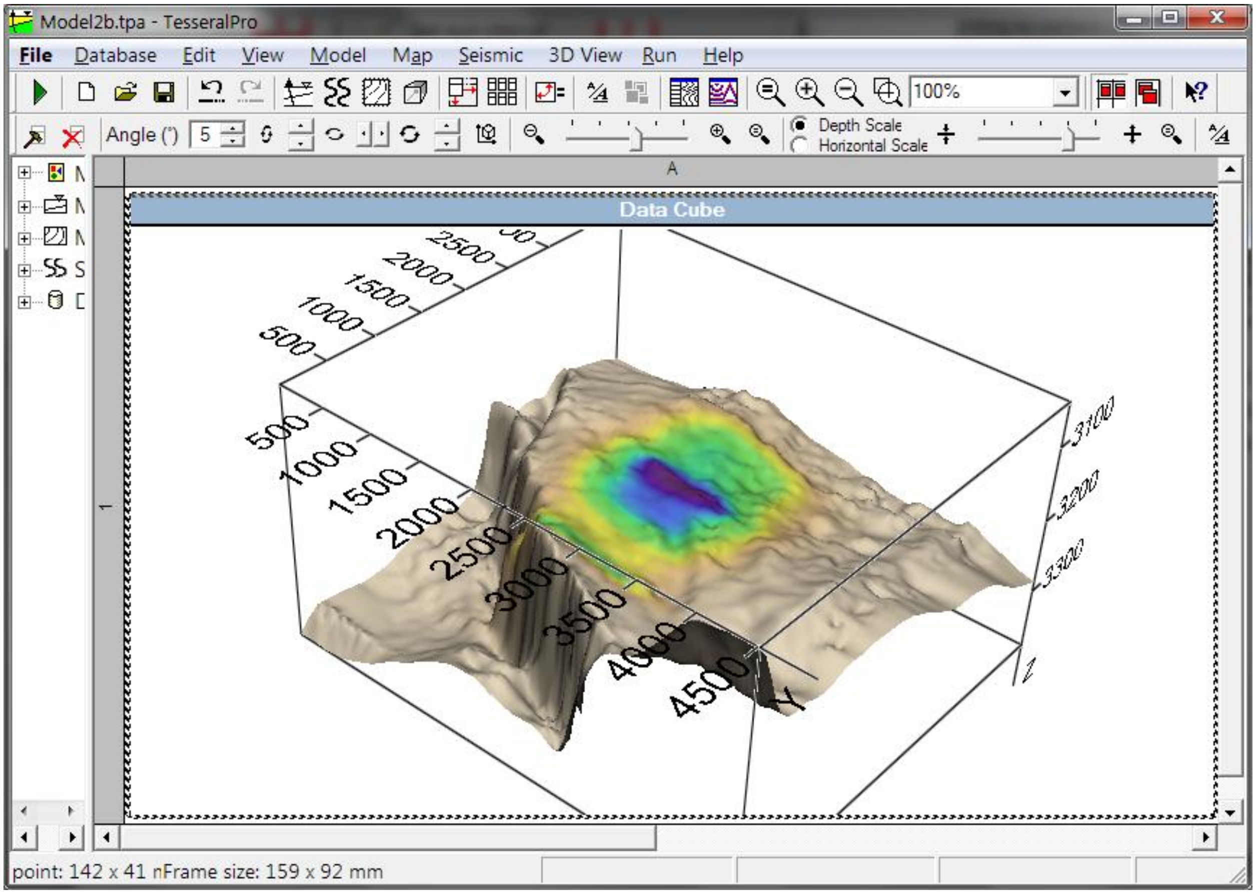
○ From file

● From project

OutputIlmn.grd; Top

PRECAMB(1)-local.grd; Top

Check the "Filling by another surface" check box, and then click "…". In the Filling by Surface dialog box select "From project" radio button, and then select the illumination map surface from the list below. Click OK in both dialogs and the surfaces are loaded into the 3D View Frame.

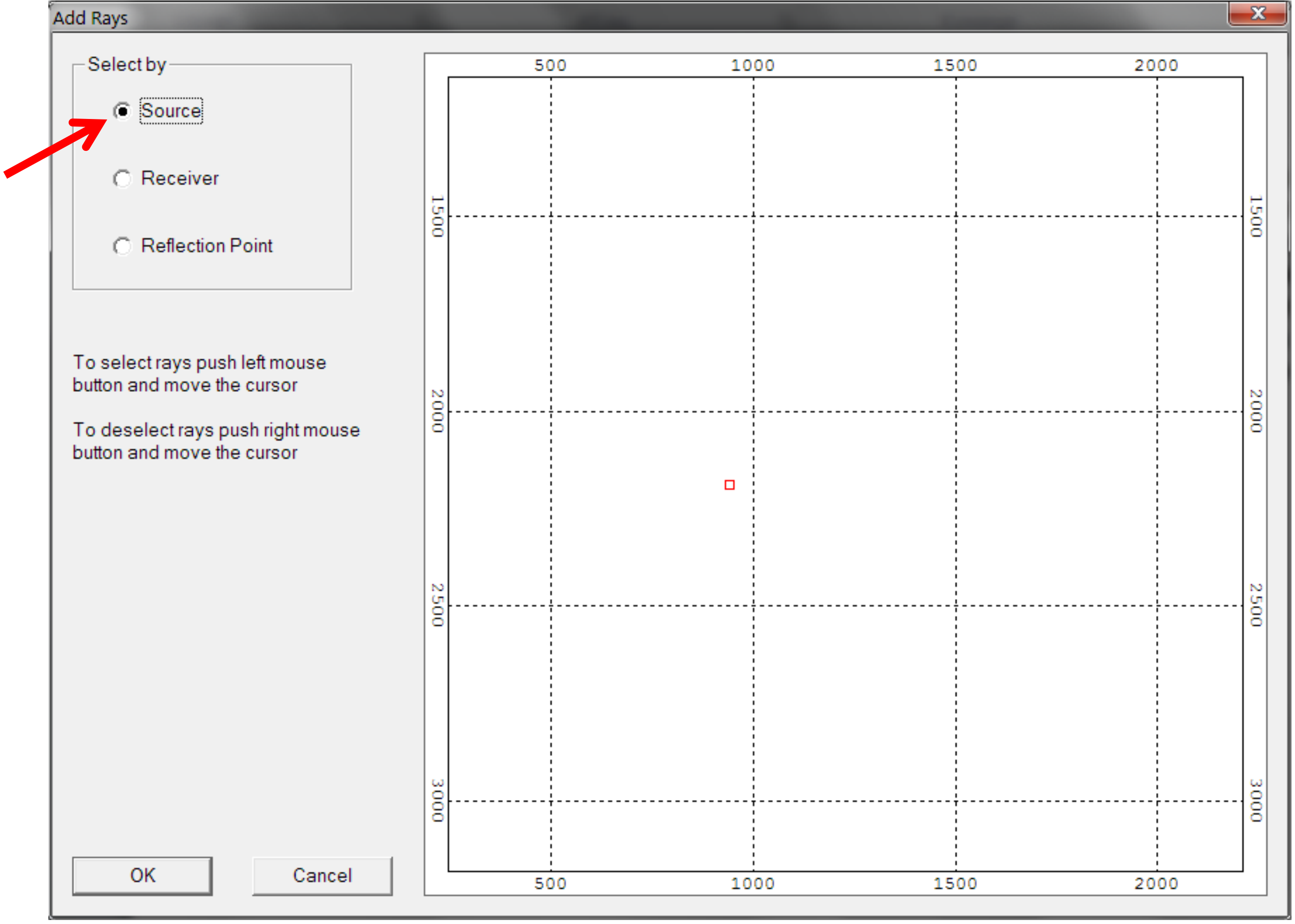

Model2b.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
Angle (°)
5
Depth Scale
Horizontal Scale
A
Data Cube
500
1000
1500
2000
2500
500
1000
1500
2000
2500
3000
3500
4000
4500
Y
3100
3200
3300
Z
point: 142 x 41 nFrame size: 159 x 92 mm

Please refer to Section ***15*** for instructions on how to adjust the 3D View display options (rotation, zooming, etc.)

9.2.5 Viewing the rays

Choose the `3D View > Add/Remove Rays…` menu command. In the Open File dialog select the file with the '.bin' extension, having the name specified in the Ray Tracing dialog (see *9.2.3*). By default, this file is named "OutputRays.bin". This file contains the catalog of all calculated rays during the simulation.

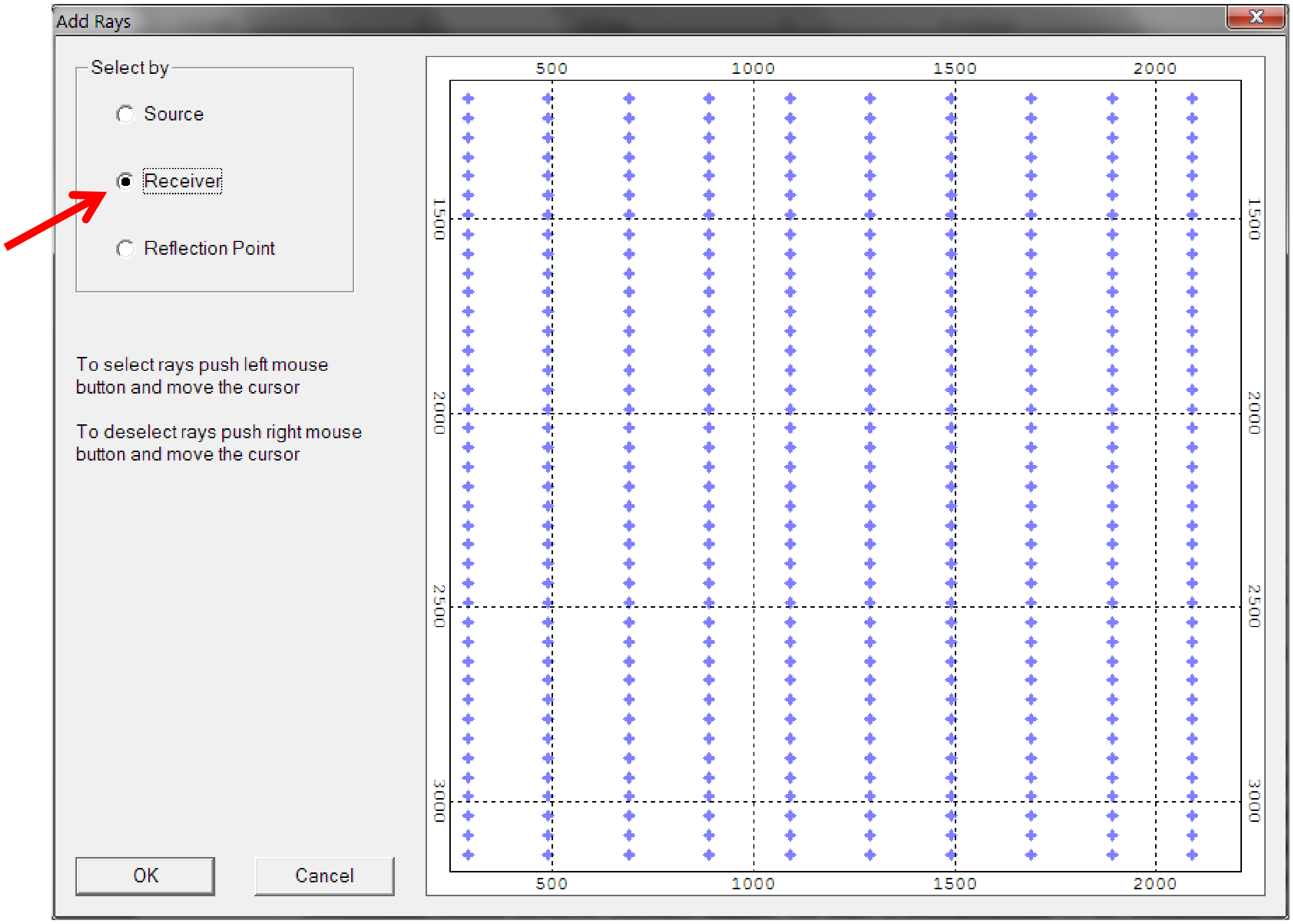
The Add Rays dialog opens:


Add Rays
Select by
● Source
○ Receiver
○ Reflection Point
OK
Cancel
500
1000
1500
2000
1500
2000
2500
3000

To select rays push left mouse button and move the cursor

To deselect rays push right mouse button and move the cursor

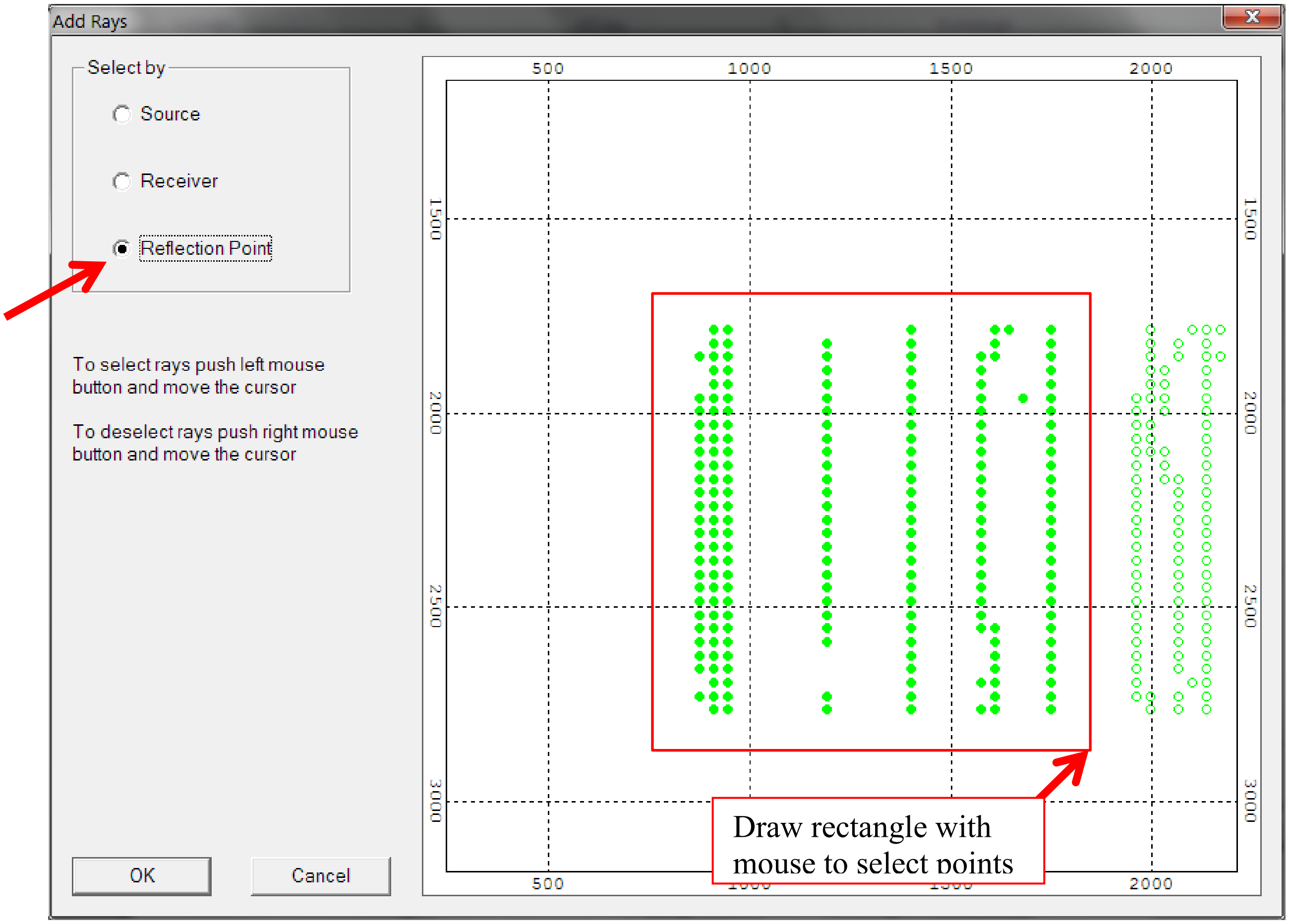
On the left, you can choose how you want to select the rays: by sources, receivers, or reflection points.



Add Rays
Select by
○ Source
● Receiver
○ Reflection Point
OK
Cancel
500
1000
1500
2000
1500
2000
2500
3000

To select rays push left mouse button and move the cursor

To deselect rays push right mouse button and move the cursor



Select by
○ Source
○ Receiver
● Reflection Point

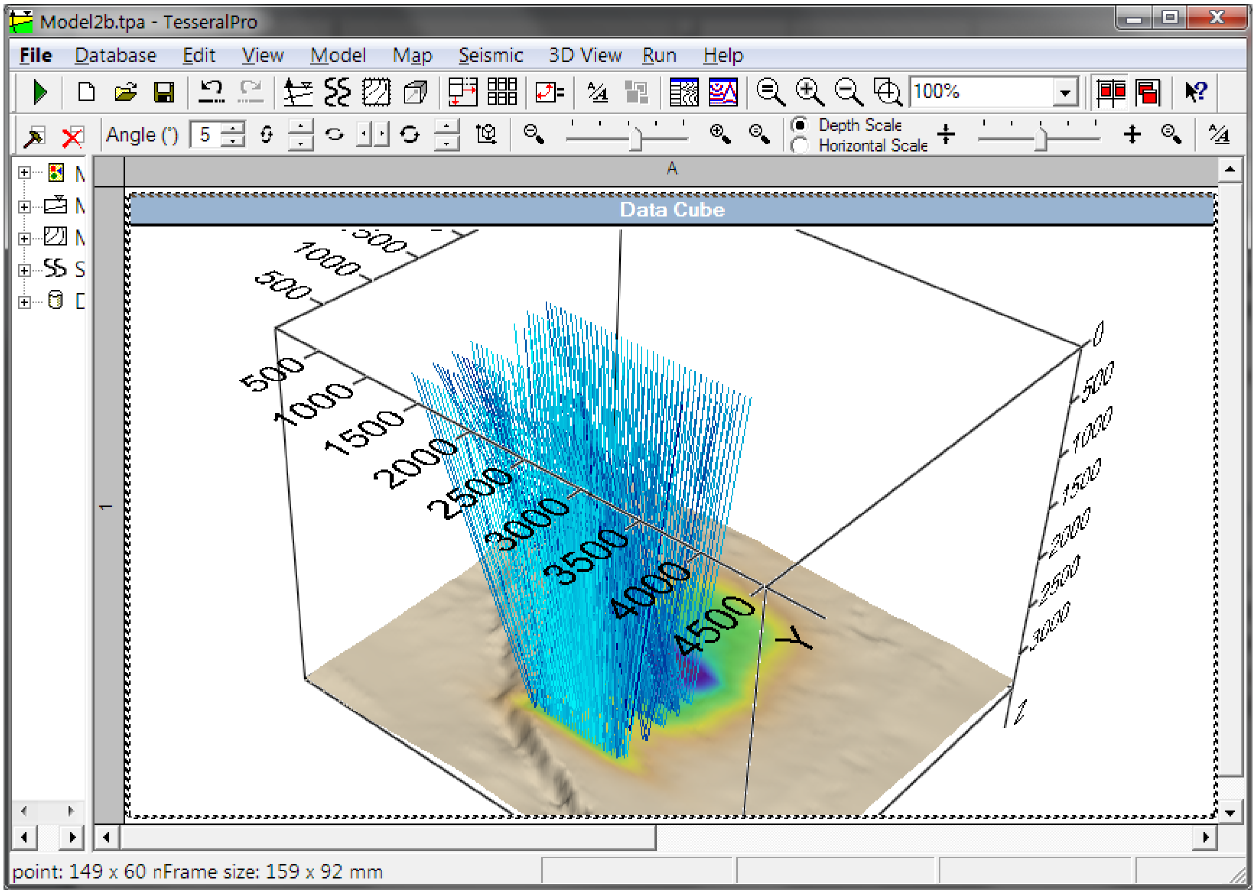
To select rays push left mouse button and move the cursor

To deselect rays push right mouse button and move the cursor

Draw rectangle with mouse to select points

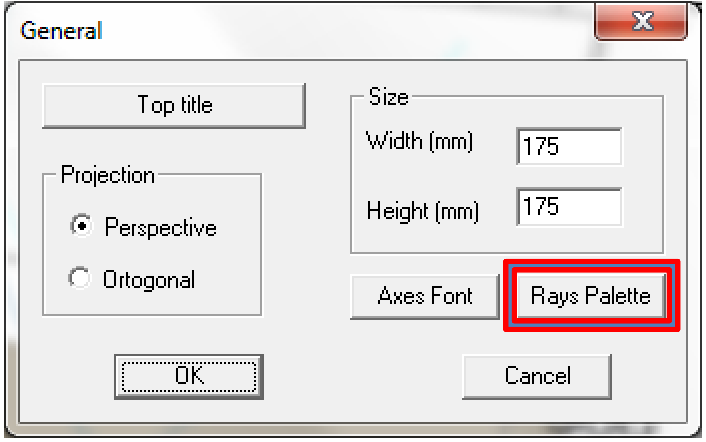
Then select the rays you want to display in the 3D View. Depending on your choice in the left of the dialog, you can select rays by sources, receivers or reflection points. Drag your mouse with the left button pressed to select the sources, receivers or reflection points; if you want to exclude certain sources, receivers or reflection points from the selection, deselect them with the same procedure but using the right mouse button.

When you click OK, the rays from the selected sources, to the selected receivers, or with the selected reflection points will be shown:


Model2b.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
Angle (°)
5
Depth Scale
Horizontal Scale
A
Data Cube
500
1000
1500
2000
2500
3000
3500
4000
4500
Y
0
500
1000
1500
2000
2500
3000
Z

point: 149 x 60 nFrame size: 159 x 92 mm

If you want to change the color palette, choose the `3D View → 3D View Frame Properties…` menu command and in the <u>General</u> dialog click the <u>Rays Palette</u> button.


General
Top title
Size
Projection
Axes Font
Rays Palette
OK
Cancel

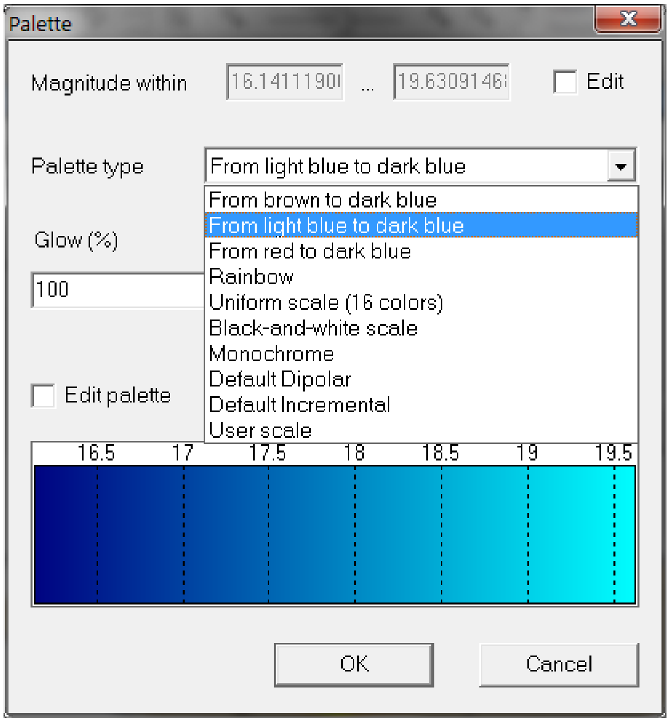
Width (mm) 175

Height (mm) 175

● Perspective

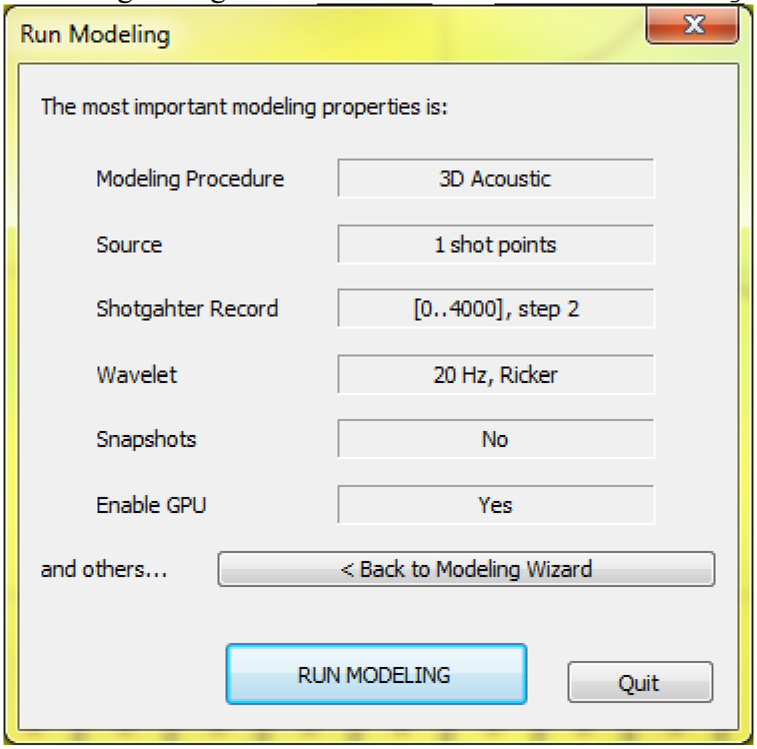
○ Ortogonal

In the <u>Palette</u> dialog box, you can change the color palette.


Palette
Magnitude within
16.1411190
...
19.630914
☐ Edit
Palette type
From light blue to dark blue
From brown to dark blue
From light blue to dark blue
From red to dark blue
Rainbow
Uniform scale (16 colors)
Black-and-white scale
Monochrome
Default Dipolar
Default Incremental
User scale
Glow (%)
100
☐ Edit palette
16.5
17
17.5
18
18.5
19
19.5
OK
Cancel

9.3 Source grouping for 3D modelling

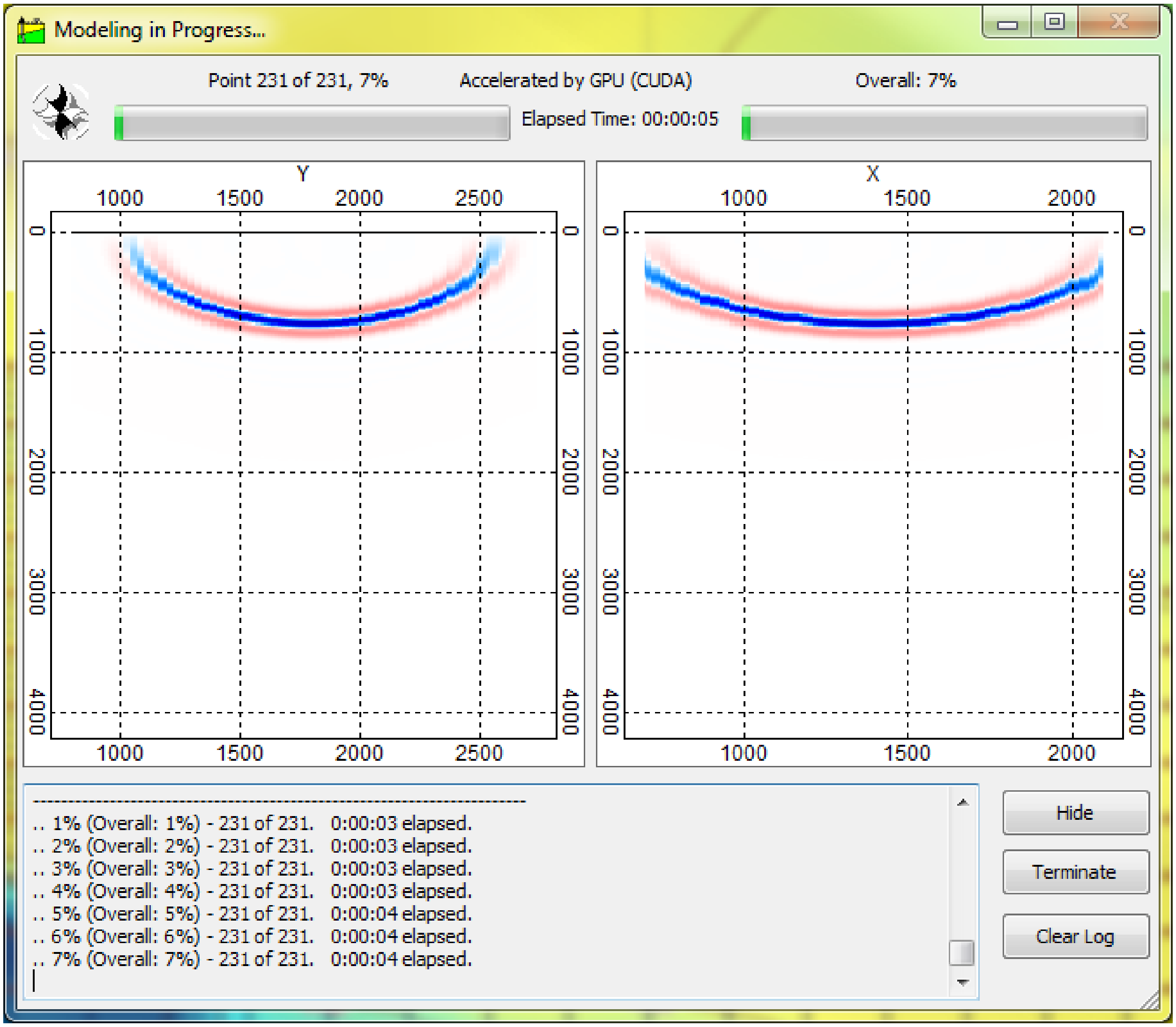
The user can also implement source grouping (i.e. simultaneous shooting from multiple sources) for any 3D modelling method. In order to implement it, the user will first need to load a surface (see Section *14*) and build a 3D observation system (see Section *9.1*). Afterwards select `Run>Run 3D Modelling` and follow the instructions in Section *7.* After specifying all modelling settings click `Finish` and `Run modelling`.



The most important modeling properties is:

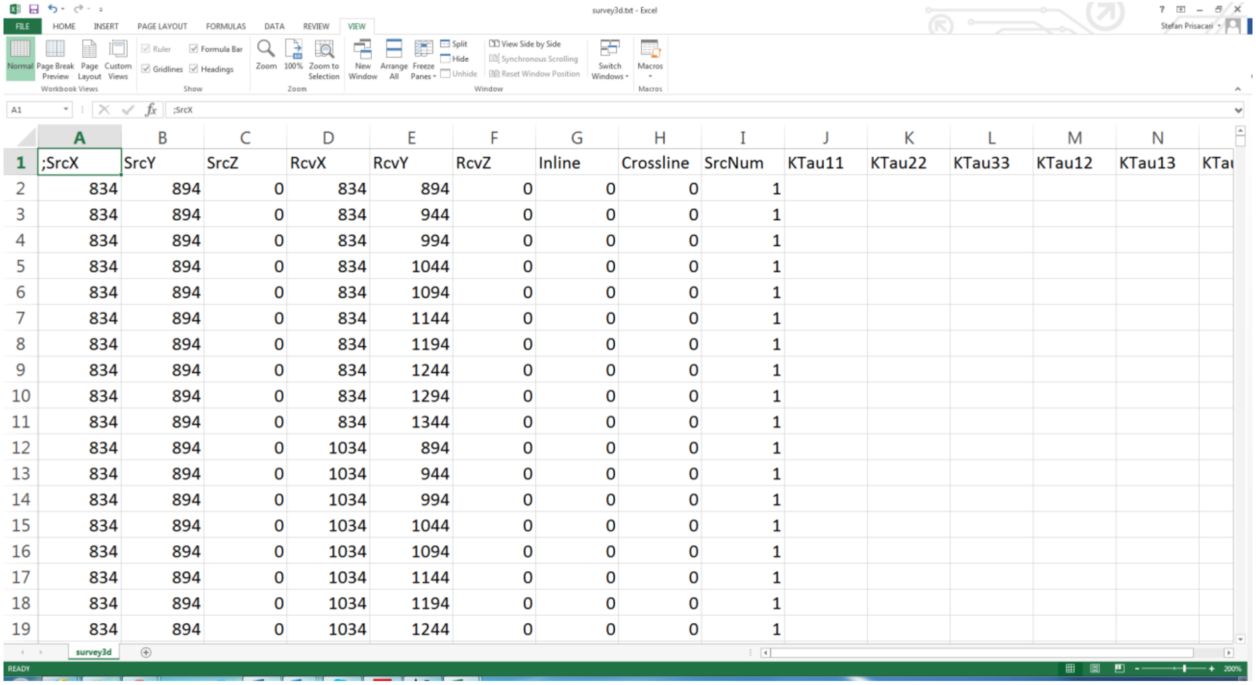
Modeling Procedure	3D Acoustic
Source	1 shot points
Shotgahter Record	[0..4000], step 2
Wavelet	20 Hz, Ricker
Snapshots	No
Enable GPU	Yes

and others...

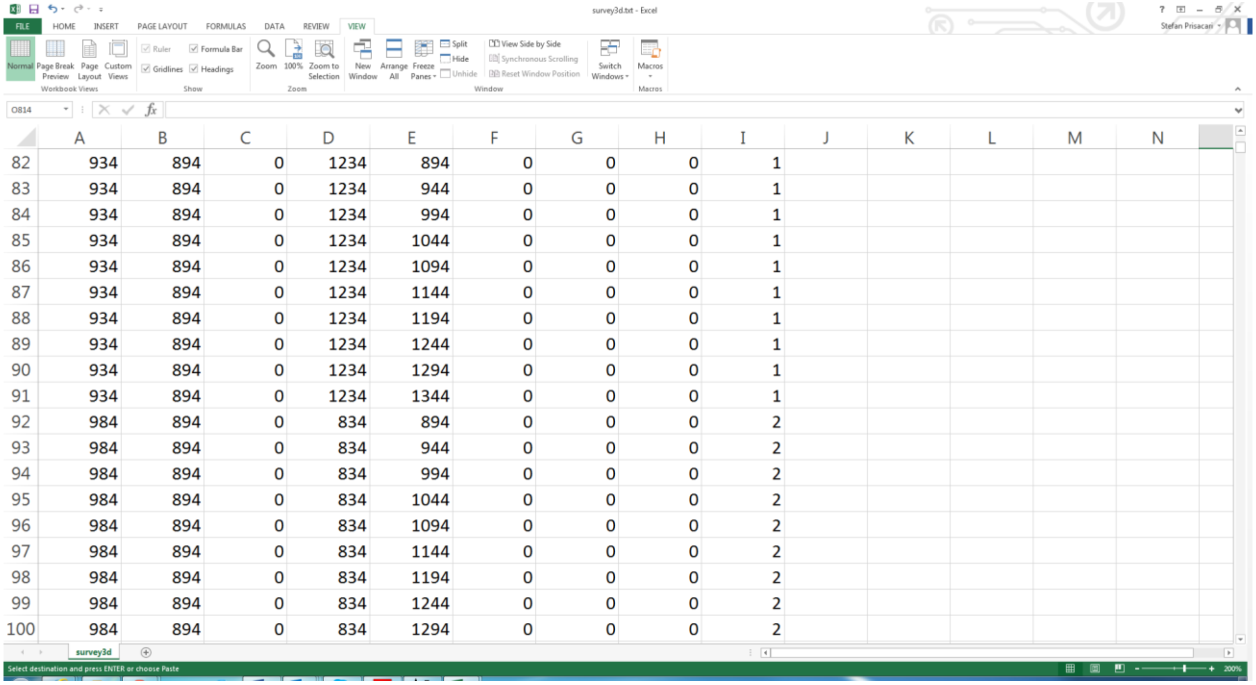

Modeling in Progress...
Point 231 of 231, 7%
Accelerated by GPU (CUDA)
Overall: 7%
Elapsed Time: 00:00:05
Y
1000
1500
2000
2500
0
1000
2000
3000
4000
X
1000
1500
2000
Hide
Terminate
Clear Log

```
-------------------------------------------------------------
.. 1% (Overall: 1%) - 231 of 231.  0:00:03 elapsed.
.. 2% (Overall: 2%) - 231 of 231.  0:00:03 elapsed.
.. 3% (Overall: 3%) - 231 of 231.  0:00:03 elapsed.
.. 4% (Overall: 4%) - 231 of 231.  0:00:03 elapsed.
.. 5% (Overall: 5%) - 231 of 231.  0:00:04 elapsed.
.. 6% (Overall: 6%) - 231 of 231.  0:00:04 elapsed.
.. 7% (Overall: 7%) - 231 of 231.  0:00:04 elapsed.
```

Click `Terminate`, as soon as at least 1% of the job has been completed. Once the job has been terminated, locate the ***survey3d.txt*** file in recently created job folder and open it in Microsoft Excel. The ***survey3d.txt*** contains the XYZ coordinates of every source-receiver pair of the designed 3D survey (i.e. the coordinates of every trace) and the user will have to fill the entire `Inline` and `Crossline` columns with zeros. Afterwards, an identical `Source Number` needs to be assigned for the sources that need to be grouped. For example if out of 100 sources in the 3D survey, the user wants to group just 5, then a `Source Number` of 1 (in actuality it can be any number) needs to be assigned to all traces pertaining to those 5 sources. In other words, every row that carries the `SrcX; SrcY; SrcZ` coordinates of the respective 5 sources need to be filled with the same number. The remaining 95 sources (that are of no interest to us), have to be assigned a different number, for example 2, so that the whole `SrcNum` column is filled. The same methodology applies if 3 or more sets of sources, have to grouped per modelling job.

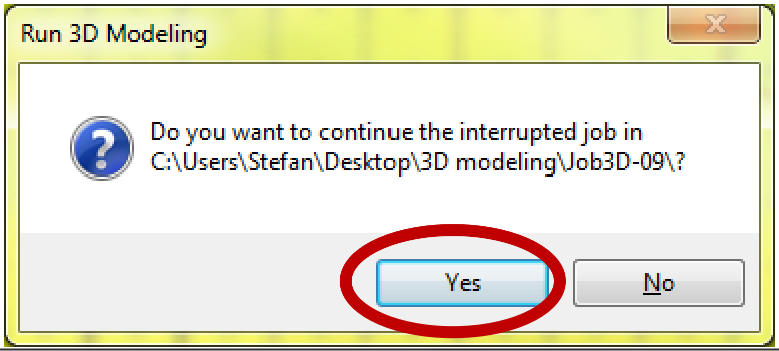

survey3d.txt - Excel
FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
Stefan Prisacari
A1
;SrcX
survey3d
READY
200%

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
1	;SrcX	SrcY	SrcZ	RcvX	RcvY	RcvZ	Inline	Crossline	SrcNum	KTau11	KTau22	KTau33	KTau12	KTau13	KTa
2	834	894	0	834	894	0	0	0	1						
3	834	894	0	834	944	0	0	0	1						
4	834	894	0	834	994	0	0	0	1						
5	834	894	0	834	1044	0	0	0	1						
6	834	894	0	834	1094	0	0	0	1						
7	834	894	0	834	1144	0	0	0	1						
8	834	894	0	834	1194	0	0	0	1						
9	834	894	0	834	1244	0	0	0	1						
10	834	894	0	834	1294	0	0	0	1						
11	834	894	0	834	1344	0	0	0	1						
12	834	894	0	1034	894	0	0	0	1						
13	834	894	0	1034	944	0	0	0	1						
14	834	894	0	1034	994	0	0	0	1						
15	834	894	0	1034	1044	0	0	0	1						
16	834	894	0	1034	1094	0	0	0	1						
17	834	894	0	1034	1144	0	0	0	1						
18	834	894	0	1034	1194	0	0	0	1						
19	834	894	0	1034	1244	0	0	0	1						

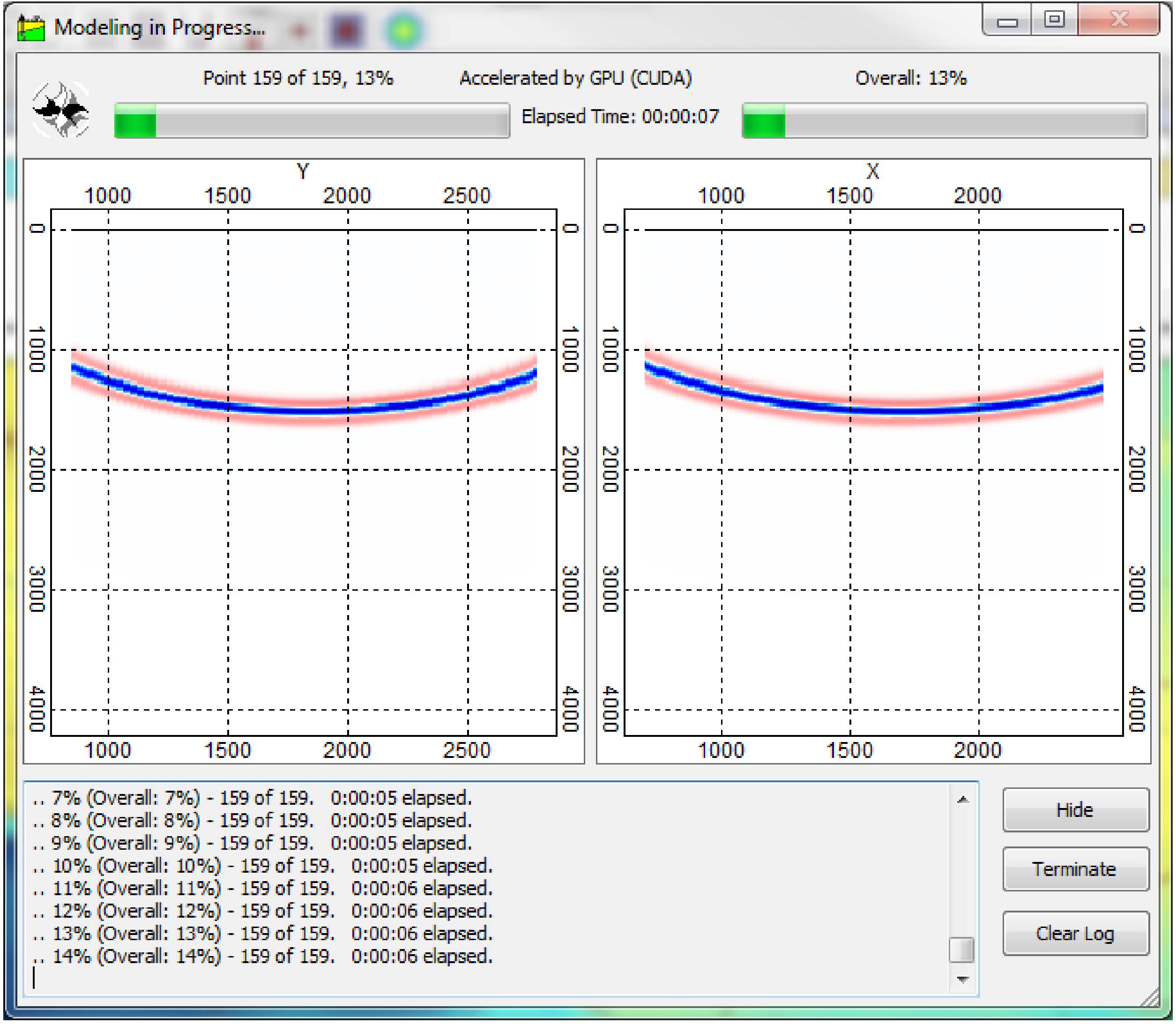

survey3d.txt - Excel
FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
Stefan Prisacari
O814
survey3d
Select destination and press ENTER or choose Paste
200%

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
82	934	894	0	1234	894	0	0	0	1					
83	934	894	0	1234	944	0	0	0	1					
84	934	894	0	1234	994	0	0	0	1					
85	934	894	0	1234	1044	0	0	0	1					
86	934	894	0	1234	1094	0	0	0	1					
87	934	894	0	1234	1144	0	0	0	1					
88	934	894	0	1234	1194	0	0	0	1					
89	934	894	0	1234	1244	0	0	0	1					
90	934	894	0	1234	1294	0	0	0	1					
91	934	894	0	1234	1344	0	0	0	1					
92	984	894	0	834	894	0	0	0	2					
93	984	894	0	834	944	0	0	0	2					
94	984	894	0	834	994	0	0	0	2					
95	984	894	0	834	1044	0	0	0	2					
96	984	894	0	834	1094	0	0	0	2					
97	984	894	0	834	1144	0	0	0	2					
98	984	894	0	834	1194	0	0	0	2					
99	984	894	0	834	1244	0	0	0	2					
100	984	894	0	834	1294	0	0	0	2					

Once the `SrcNum` column has all been filled, save and overwrite the existing ***survey3d.txt*** file with the updated one (make sure to also save it in TXT format). Afterwards, go back your map frame which contains the previously build 3D survey and click `Run>Run 3D Modelling>Yes`.


Run 3D Modeling
Yes
No

Do you want to continue the interrupted job in C:\Users\Stefan\Desktop\3D modeling\Job3D-09\?


Modeling in Progress...
Point 159 of 159, 13%
Accelerated by GPU (CUDA)
Overall: 13%
Elapsed Time: 00:00:07
Y
1000
1500
2000
2500
0
1000
2000
3000
4000
X
1000
1500
2000
Hide
Terminate
Clear Log

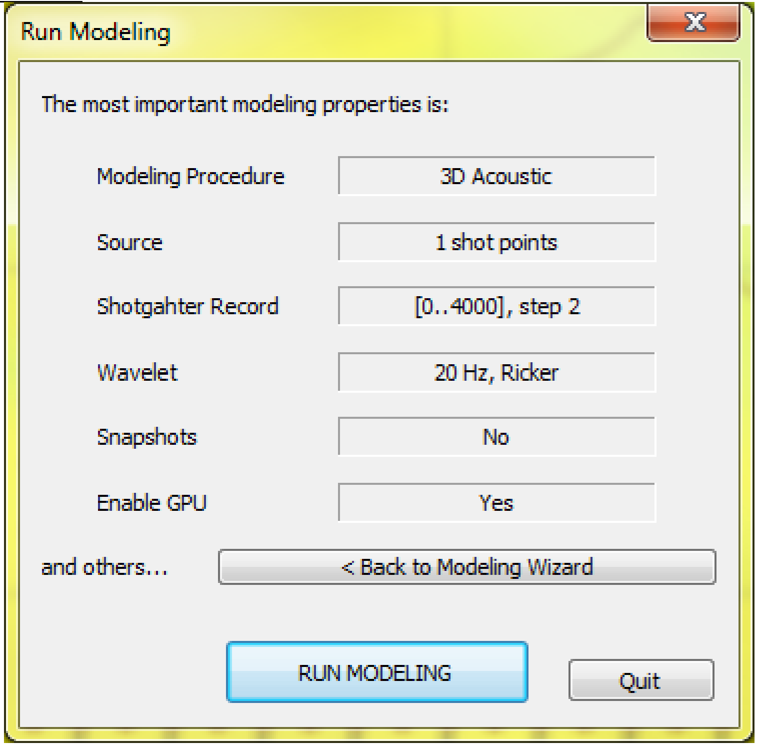
```
.. 7% (Overall: 7%) - 159 of 159.  0:00:05 elapsed.
.. 8% (Overall: 8%) - 159 of 159.  0:00:05 elapsed.
.. 9% (Overall: 9%) - 159 of 159.  0:00:05 elapsed.
.. 10% (Overall: 10%) - 159 of 159.  0:00:05 elapsed.
.. 11% (Overall: 11%) - 159 of 159.  0:00:06 elapsed.
.. 12% (Overall: 12%) - 159 of 159.  0:00:06 elapsed.
.. 13% (Overall: 13%) - 159 of 159.  0:00:06 elapsed.
.. 14% (Overall: 14%) - 159 of 159.  0:00:06 elapsed.
```

Once the computation is complete, the total number of seismograms produced will equal the total number of shot groupings. For the example above, you will end up with a total of 2 shot gathers, (one for the 5 grouped sources and another one for the remaining 95 grouped sources).

9.4 Double couple sources in 3D modelling

It is now possible to simulate arbitrary oriented double couple sources, expressed by stress matrices (or moment tensors) in ***survey3d.txt***.
This functionality can be implemented for any 3D modelling method (except for the 3D acoustic).

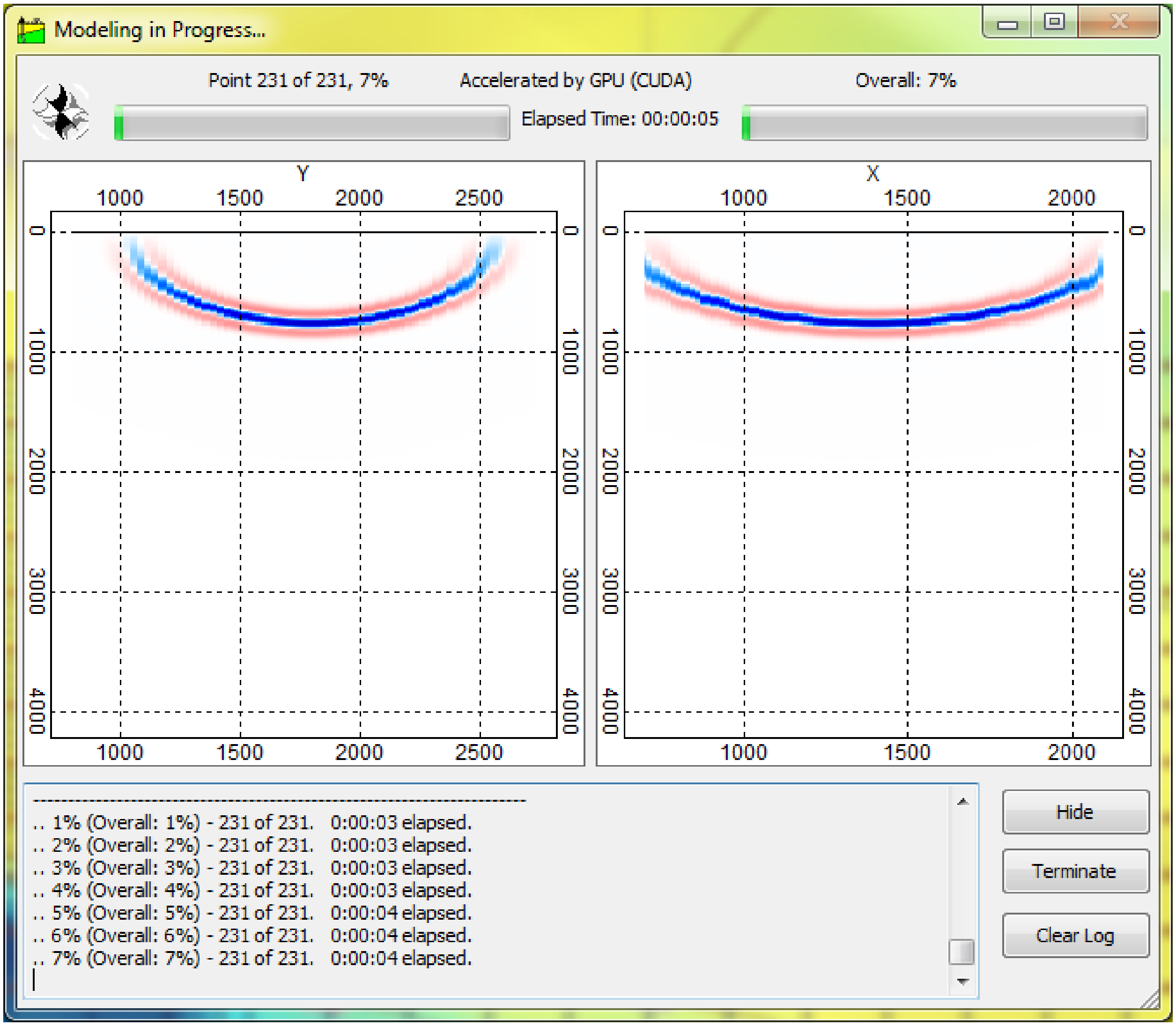
In order to implement it, the user will first need to load a surface (see Section *14*) and build a 3D observation system (see Section *9.1*). Afterwards click `Run>Run 3D Modelling` and follow the instruction in Section *7.* After specifying all modelling settings click `Finish` and `Run modelling`.


Run Modeling

The most important modeling properties is:

Modeling Procedure	3D Acoustic
Source	1 shot points
Shotgahter Record	[0..4000], step 2
Wavelet	20 Hz, Ricker
Snapshots	No
Enable GPU	Yes

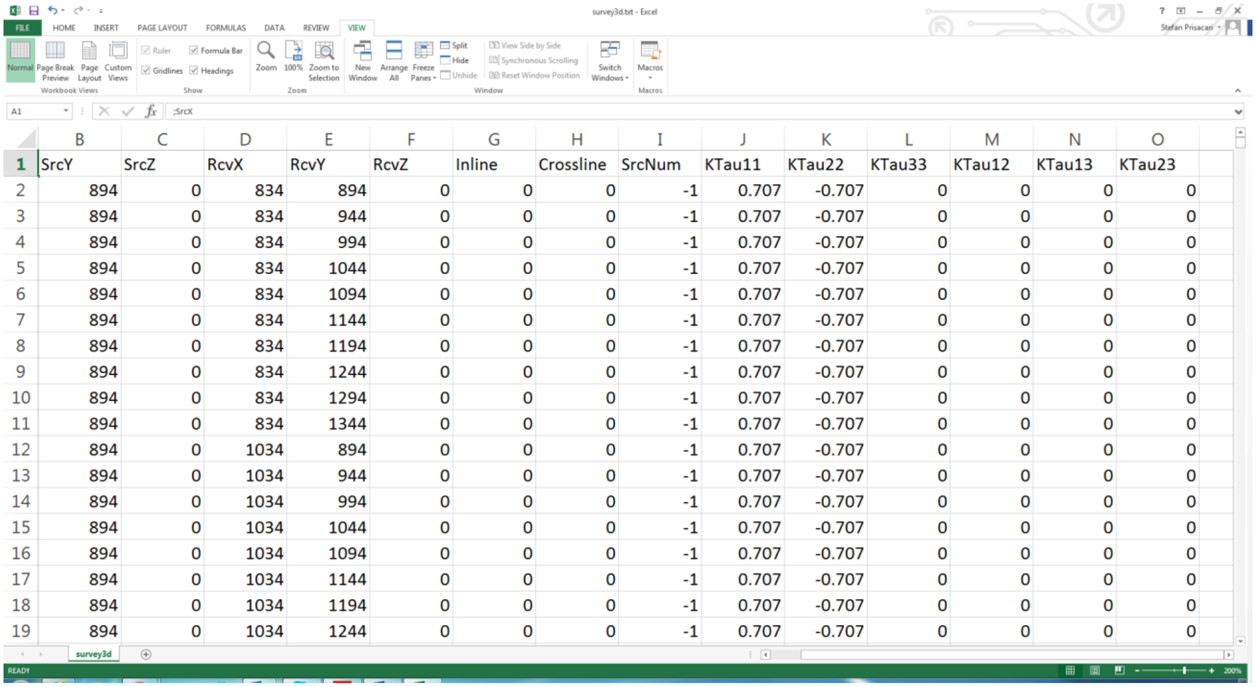
and others...


Modeling in Progress...
Point 231 of 231, 7%
Accelerated by GPU (CUDA)
Overall: 7%
Elapsed Time: 00:00:05
Y
1000
1500
2000
2500
0
1000
2000
3000
4000
X
1000
1500
2000
Hide
Terminate
Clear Log

```
---------------------------------------------------------------------
.. 1% (Overall: 1%) - 231 of 231.   0:00:03 elapsed.
.. 2% (Overall: 2%) - 231 of 231.   0:00:03 elapsed.
.. 3% (Overall: 3%) - 231 of 231.   0:00:03 elapsed.
.. 4% (Overall: 4%) - 231 of 231.   0:00:03 elapsed.
.. 5% (Overall: 5%) - 231 of 231.   0:00:04 elapsed.
.. 6% (Overall: 6%) - 231 of 231.   0:00:04 elapsed.
.. 7% (Overall: 7%) - 231 of 231.   0:00:04 elapsed.
```

Click `Terminate`, as soon as at least 1% of the job has been completed.

Once the job has been terminated, locate the ***survey3d.txt*** file from the recently created job folder and open it in Microsoft Excel. The ***survey3d.txt*** contains the XYZ coordinates of every source-receiver pair of the designed 3D survey (i.e. the coordinates of every trace) and the user will have to fill the entire `Inline`, `Crossline` columns with zeros and the `SrcNum` with -1, which simply disables it during computation!



	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	SrcY	SrcZ	RcvX	RcvY	RcvZ	Inline	Crossline	SrcNum	KTau11	KTau22	KTau33	KTau12	KTau13	KTau23
2	894	0	834	894	0	0	0	-1	0.707	-0.707	0	0	0	0
3	894	0	834	944	0	0	0	-1	0.707	-0.707	0	0	0	0
4	894	0	834	994	0	0	0	-1	0.707	-0.707	0	0	0	0
5	894	0	834	1044	0	0	0	-1	0.707	-0.707	0	0	0	0
6	894	0	834	1094	0	0	0	-1	0.707	-0.707	0	0	0	0
7	894	0	834	1144	0	0	0	-1	0.707	-0.707	0	0	0	0
8	894	0	834	1194	0	0	0	-1	0.707	-0.707	0	0	0	0
9	894	0	834	1244	0	0	0	-1	0.707	-0.707	0	0	0	0
10	894	0	834	1294	0	0	0	-1	0.707	-0.707	0	0	0	0
11	894	0	834	1344	0	0	0	-1	0.707	-0.707	0	0	0	0
12	894	0	1034	894	0	0	0	-1	0.707	-0.707	0	0	0	0
13	894	0	1034	944	0	0	0	-1	0.707	-0.707	0	0	0	0
14	894	0	1034	994	0	0	0	-1	0.707	-0.707	0	0	0	0
15	894	0	1034	1044	0	0	0	-1	0.707	-0.707	0	0	0	0
16	894	0	1034	1094	0	0	0	-1	0.707	-0.707	0	0	0	0
17	894	0	1034	1144	0	0	0	-1	0.707	-0.707	0	0	0	0
18	894	0	1034	1194	0	0	0	-1	0.707	-0.707	0	0	0	0
19	894	0	1034	1244	0	0	0	-1	0.707	-0.707	0	0	0	0

Introduce the moment tensor for `KTau11`, `KTau22`, `KTau33`, `KTau12`, `KTau13`, `KTau23`, for all relevant sources.

Please make sure to assign identical moment tensors to all traces, pertaining to a distinct source. In other words, the moment tensor needs to remain constant for every source-receiver pair in the table.

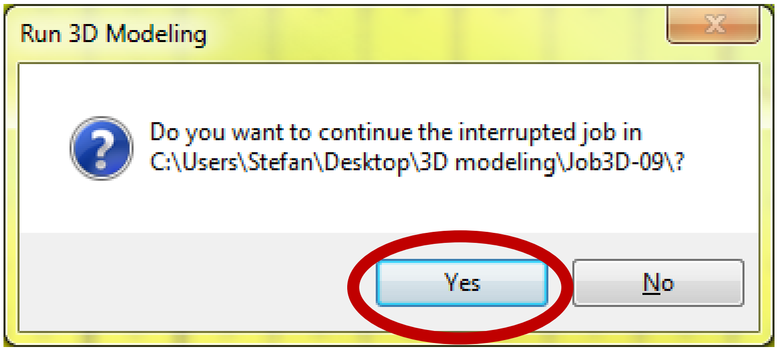
Once the `KTau` columns have been filled, save and overwrite the existing ***survey3d.txt*** file with the updated one (make sure to also save it in TXT format).

Now open the ***runtask.ini*** file, located in the same modelling folder as ***survey3d.txt*** and change

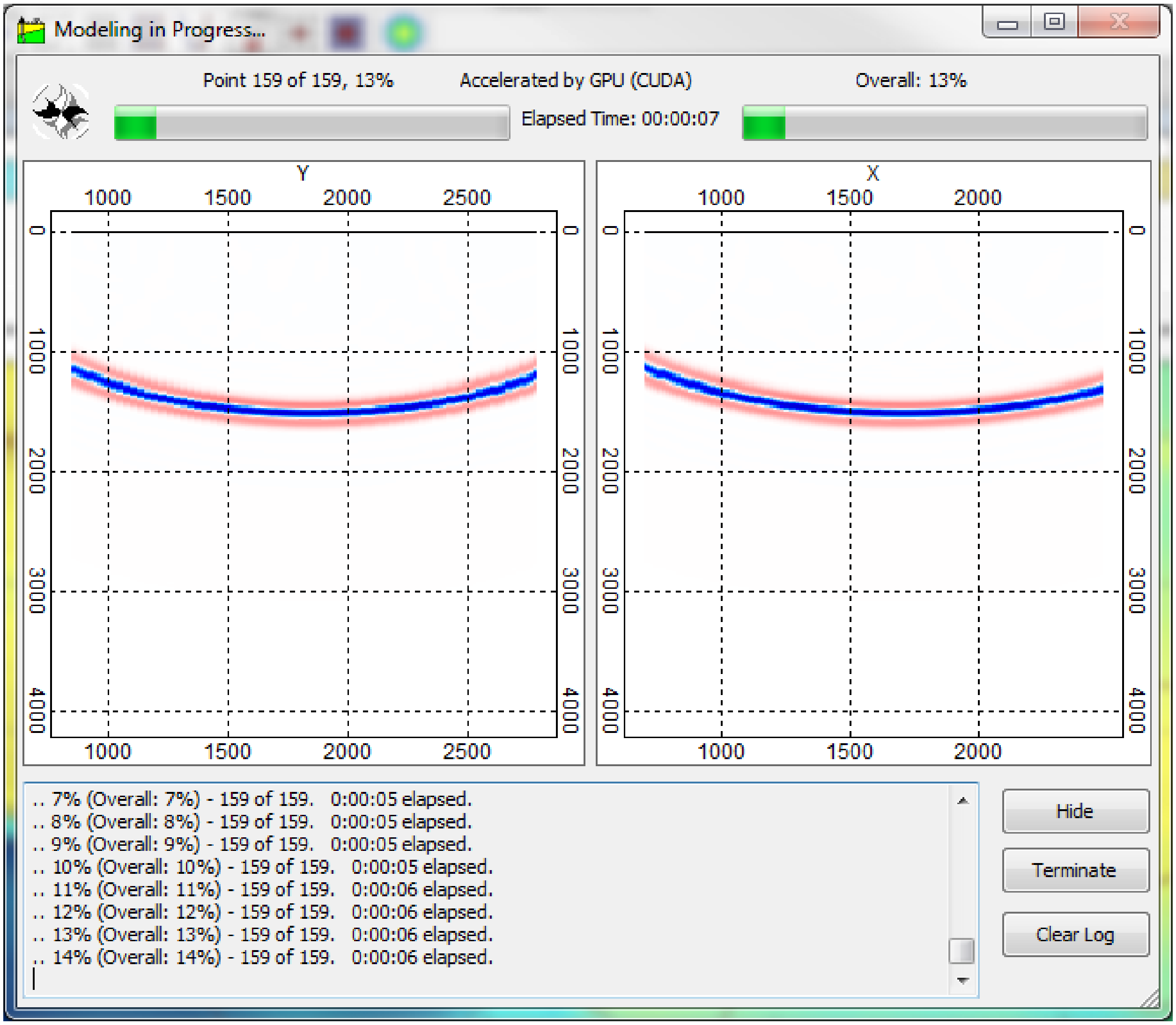
[Source]
Type=0; Omnidirectional
to
[Source]
Type=10; Double Couple

Afterwards, save the ***runtask.ini*** file (`File>Save)` in the exact same location.

Then, go back your map frame which contains the previously build 3D survey and click `Run>Run 3D Modelling>Yes`.


Run 3D Modeling
Yes
No

Do you want to continue the interrupted job in C:\Users\Stefan\Desktop\3D modeling\Job3D-09\?


Modeling in Progress...
Y
1000
1500
2000
2500
0
1000
2000
3000
4000
X
1000
1500
2000
Hide
Terminate
Clear Log

Point 159 of 159, 13%

Accelerated by GPU (CUDA)

Overall: 13%

Elapsed Time: 00:00:07

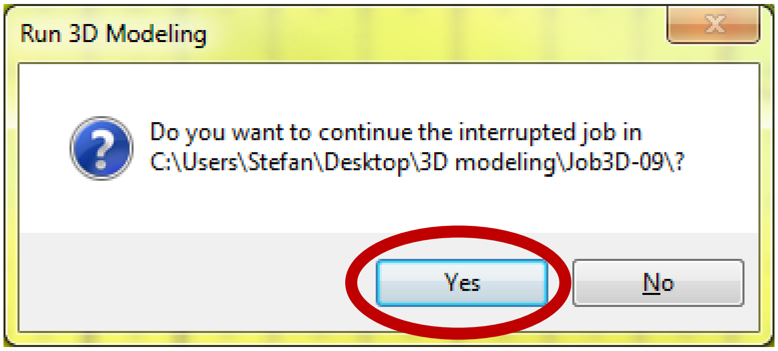
```
.. 7% (Overall: 7%) - 159 of 159.  0:00:05 elapsed.
.. 8% (Overall: 8%) - 159 of 159.  0:00:05 elapsed.
.. 9% (Overall: 9%) - 159 of 159.  0:00:05 elapsed.
.. 10% (Overall: 10%) - 159 of 159.  0:00:05 elapsed.
.. 11% (Overall: 11%) - 159 of 159.  0:00:06 elapsed.
.. 12% (Overall: 12%) - 159 of 159.  0:00:06 elapsed.
.. 13% (Overall: 13%) - 159 of 159.  0:00:06 elapsed.
.. 14% (Overall: 14%) - 159 of 159.  0:00:06 elapsed.
```

9.4.1 Using the same moment tensor for all sources

If the user would like to use the same moment tensor for all sources in the 3D survey, then it is sufficient to **ONLY** modify the ***runtask.ini*** file as follows (leaving the ***survey3d.txt*** intact):

Remove
[Source]
Type=0; Omnidirectional
And replace it with:
[Source]
Type=8;
K11=…;
K22=…;
K33=…;
K12=…;
K13=…;
K23=…;

Once the moment tensor has been specified, save the ***runtask.ini***, go back to your map frame which contains the previously build 3D survey and click `Run>Run 3D Modelling>Yes`.


Run 3D Modeling

Do you want to continue the interrupted job in C:\Users\Stefan\Desktop\3D modeling\Job3D-09\?

9.4.2 Using 2D douple couple sources for 3D modeling

It is also possible to have all double couple source propagate in 2D only (i.e. in XZ, YZ or XY direction). For that you will have to modify the ***runtask.ini*** file as follows:

Remove:

[Source]
Type=0; Omnidirectional

And replace it with:

[Source]
Type=8;
DoubleCoupleAxis=XZ

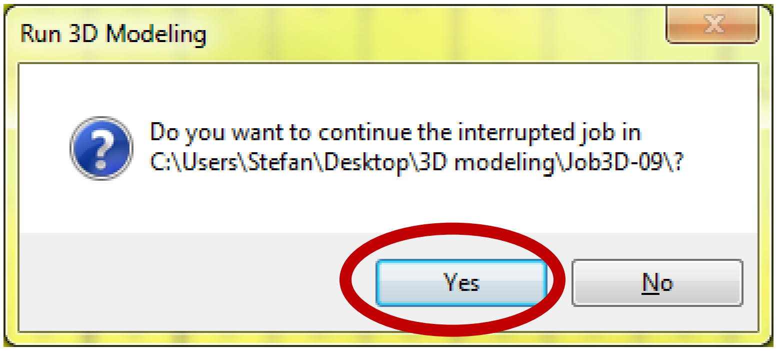
Or

Type=8
DoubleCoupleAxis=XY

Or

Type=8
DoubleCoupleAxis=YZ

Afterwards, save the ***runtask.ini***, go back your map frame which contains the previously build 3D survey and click `Run>Run 3D Modelling>Yes`.



Run 3D Modeling

Do you want to continue the interrupted job in C:\Users\Stefan\Desktop\3D modeling\Job3D-09\?

10 Processing of seismic gather

Some of the commands in the `Run` menu are for processing generated synthetic gathers.

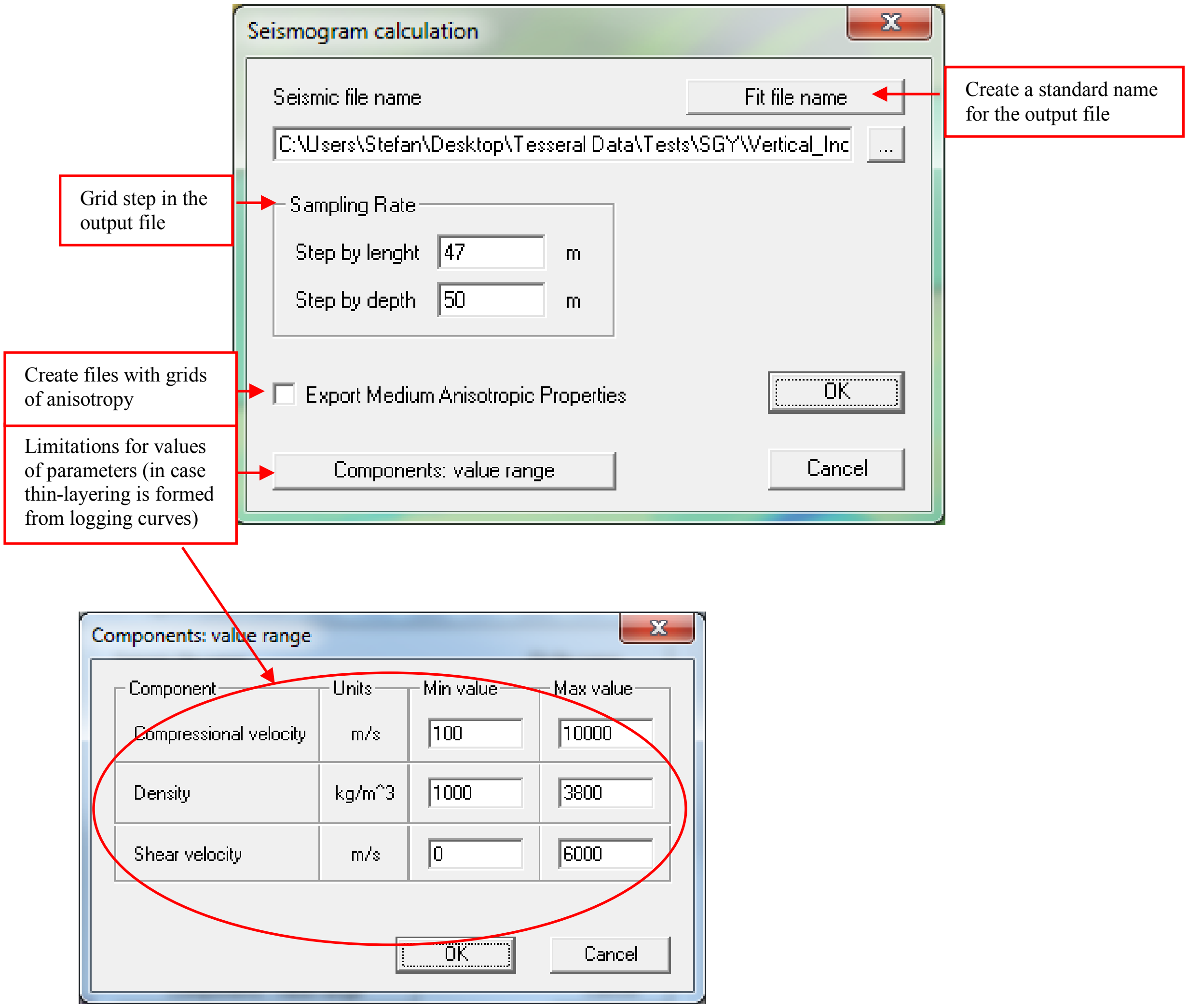
IMPORTANT NOTE!

All processing history and user defined settings are saved in the `computation.log`

10.1 General Purpose Procedures

The command export Model to Seismic Format is to save the Model Frame into a 2D grid of seismic format.

In the Model Frame, the model consists of polygons (model in vector format). In some other programs such as ray tracing, migration and other processing procedures in Tesseral Pro, the input model is assumed to be in form of grid. To export Model Frame to a grid file, use the command `Model > Export to Seismic Format (SEG-Y, TGR)`.



Seismic file name: C:\Users\Stefan\Desktop\Tesseral Data\Tests\SGY\Vertical_Inc

Sampling Rate

Step by lenght 47 m

Step by depth 50 m

☐ Export Medium Anisotropic Properties

Component	Units	Min value	Max value
Compressional velocity	m/s	100	10000
Density	kg/m^3	1000	3800
Shear velocity	m/s	0	6000

Create a standard name for the output file

Grid step in the output file

Create files with grids of anisotropy

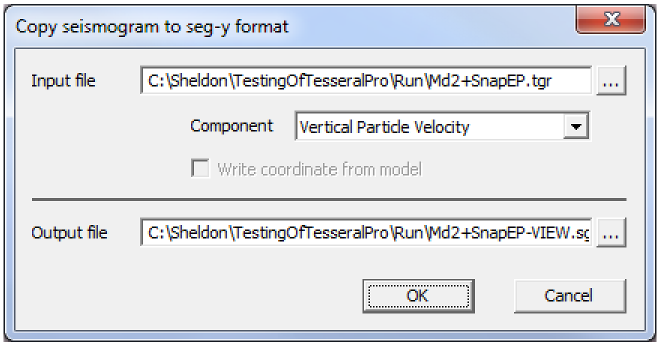
Limitations for values of parameters (in case thin-layering is formed from logging curves)

The output file may be in SEG-Y format. For isotropic model, 3 output files are created for the compressional velocity, shear velocity (**<name of the output file>–PQR_R.SGY**) and density (**<name of the output file>–PQR_Q.SGY**) components respectively.

The output grid files may be in TGR format (i.e. the internal Tesseral format). Separate output files are created for all 3 components of the depth model (compressional, shear velocity and density), as well as anisotropy parameters if the checkbox `Export Medium Anisotropic Properties` was checked.

10.1.1 Copy Gather to SEG-Y Format

The command `Run > General Purpose Procedures > Copy Seismogram to SEG-Y Format` is used to transform files from the internal TGR or SDC PC formats into the standard SEG-Y format.


Copy seismogram to seg-y format

Input file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+SnapEP.tgr

Component: Vertical Particle Velocity

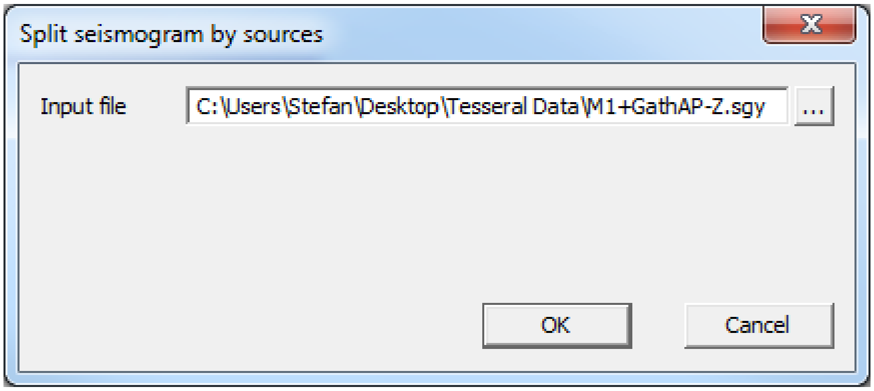
☐ Write coordinate from model

Output file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+SnapEP-VIEW.sg

The TGR format does not contain the geographical coordinates of the traces and the altitudes of the receivers. Check the box `Write coordinate from model` to obtain this information from the Model Frame and then write it into the trace header of the output SEG-Y file.

10.1.2 Split Seismogram by Shotgathers

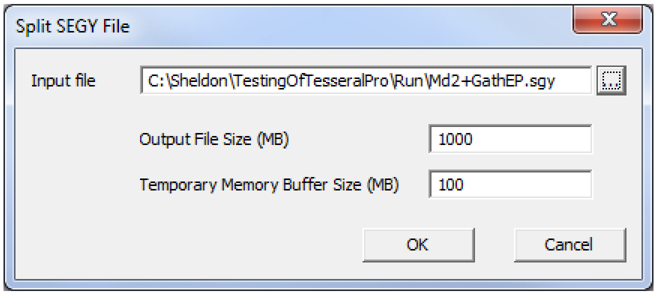
The command `Run > General Purpose Procedures > Split Seismogram by Shotgathers` is for splitting merged synthetic gathers into separate files in terms of the number of shot points (one file for each shot gather).



Input file: C:\Users\Stefan\Desktop\Tesseral Data\M1+GathAP-Z.sgy

10.1.3 Split SEG-Y File into Pieces of Limited Size

The command `Run > General Purpose Procedures > Split SEG-Y File by Limited Size Pieces` is to split the SEG-Y files into separate files, each file not exceeding the size specified in the `Output file Size (MB)` parameter.



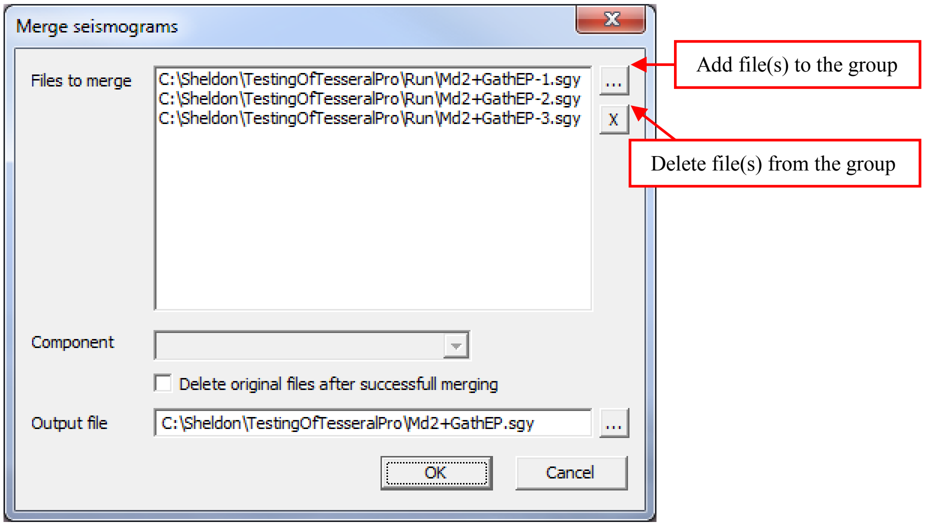
Input file C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP.sgy

Output File Size (MB) 1000

Temporary Memory Buffer Size (MB) 100

10.1.4 Merge Seismograms

The command `Run > General Purpose Procedures > Merge Seismograms` is for merging the selected files into one (the output file will have all the traces of the input files in the same order as they were entered in the list). If the coordinates of the selected files match each other exactly, the procedure will work differently (it will stack the traces and the output file will have the same number of traces as the input one). This procedure can be used to sum the different cubes after migration.



Files to merge
C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-1.sgy
C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-2.sgy
C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-3.sgy

☐ Delete original files after successfull merging

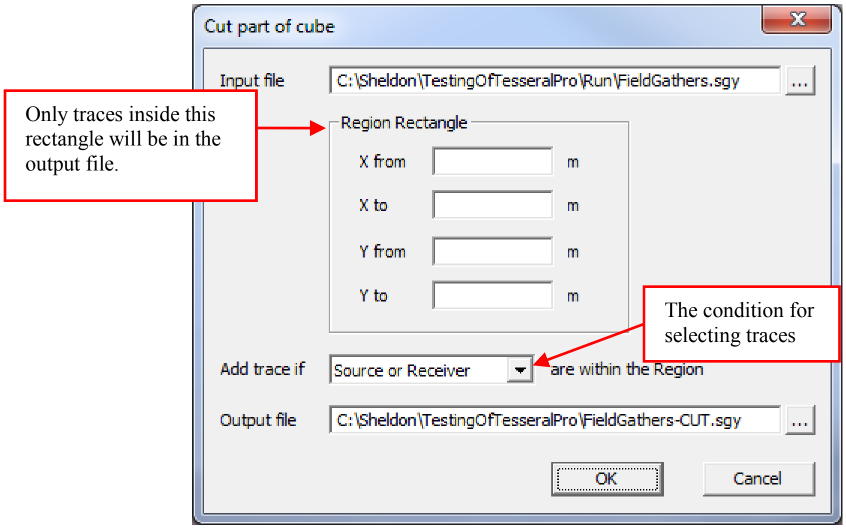
Output file C:\Sheldon\TestingOfTesseralPro\Md2+GathEP.sgy

Add file(s) to the group

Delete file(s) from the group

10.1.5 Cut Out Cube/Section

The command `Run > General Purpose Procedures > Cut Out Cube/Section` is mainly used for preparing field gathers for duplex wave migration or for extracting part of the traces falling into a user-defined rectangle. It can speed up DWM processing for a huge dataset.



Input file: C:\Sheldon\TestingOfTesseralPro\Run\FieldGathers.sgy

Add trace if: Source or Receiver are within the Region

Output file: C:\Sheldon\TestingOfTesseralPro\FieldGathers-CUT.sgy

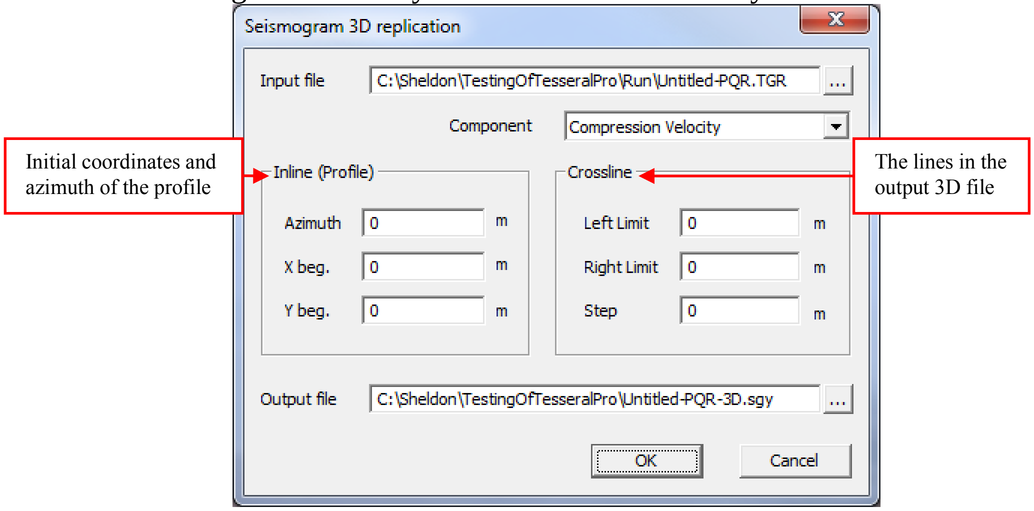
Only traces inside this rectangle will be in the output file.

The condition for selecting traces

10.1.6 3D Replication

The command `Run > General Purpose Procedures > 3D Replication` is used for:

- Creating the 3D acquisition data (multiple shot lines) from a single shot line (with multiple receiver lines) generated by 2.5D modeling to create a true 3D dataset from 2D acquisition.
- Creating a 3D velocity model from a 2D velocity model.



Input file: C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.TGR

Component: Compression Velocity

Inline (Profile)

Azimuth: 0 m

X beg.: 0 m

Y beg.: 0 m

Crossline

Left Limit: 0 m

Right Limit: 0 m

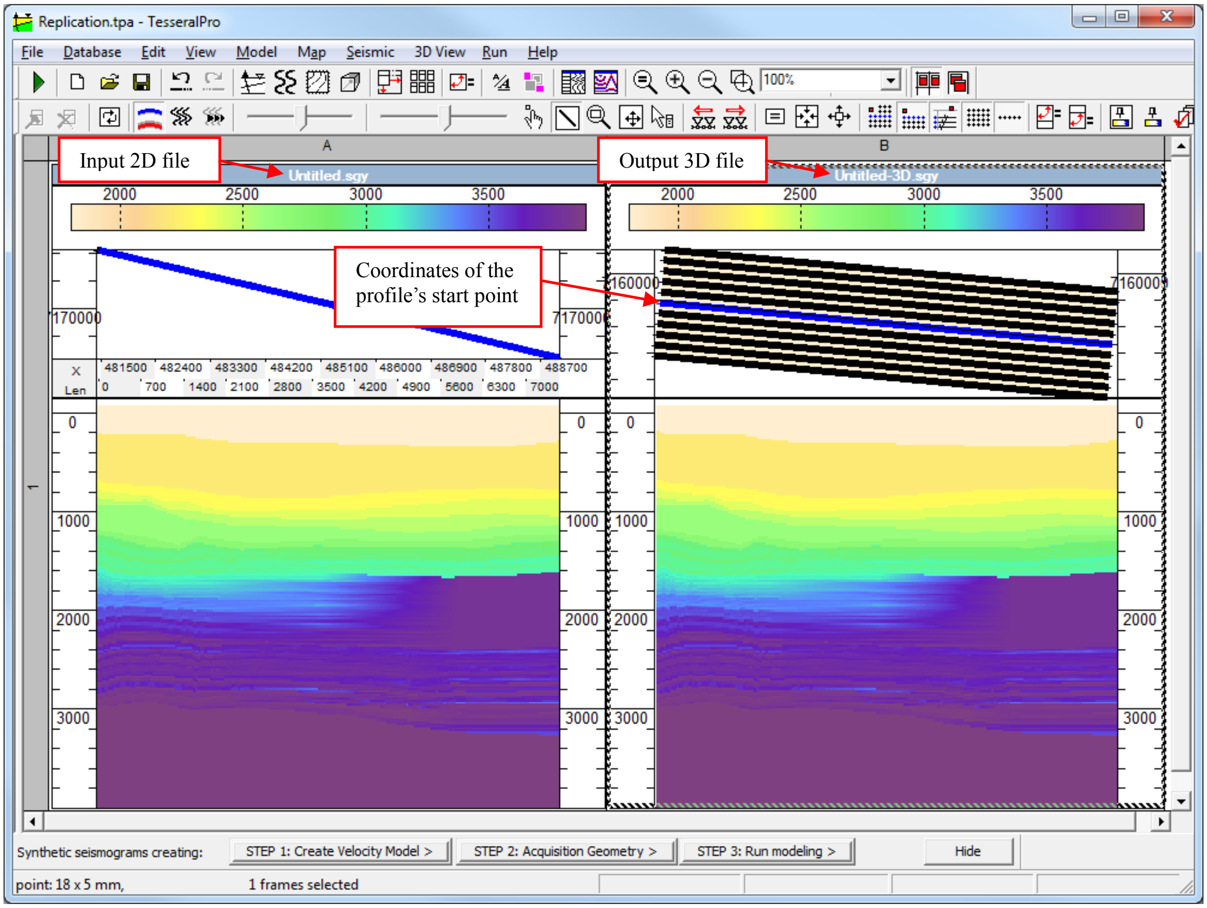
Step: 0 m

Output file: C:\Sheldon\TestingOfTesseralPro\Untitled-PQR-3D.sgy

Initial coordinates and azimuth of the profile

The lines in the output 3D file

NOTE: `Input File` is a depth velocity model or gathers of a single shot line (grid in SEG-Y or TGR format). To obtain depth velocity model in SEG-Y or TGR format, the command `Model > Export to Seismic Format (SEG-Y, TGR)` is used.


Replication.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
B
Untitled.sgy
Untitled-3D.sgy
2000 2500 3000 3500
170000
160000
X
Len
481500 482400 483300 484200 485100 486000 486900 487800 488700
0 700 1400 2100 2800 3500 4200 4900 5600 6300 7000
0 1000 2000 3000
1
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 18 x 5 mm,
1 frames selected

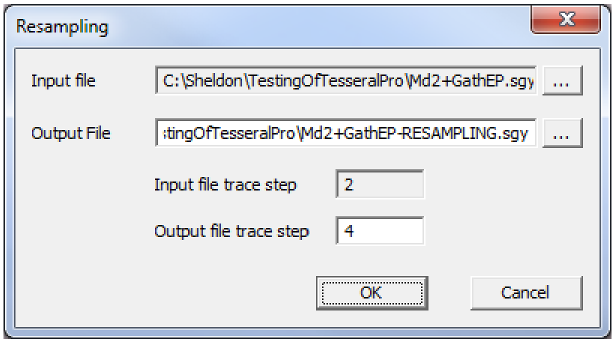
Input 2D file

Output 3D file

Coordinates of the profile's start point

10.1.7 SEG-Y File Resampling

Choose the command `Run > General Purpose Procedures > SEG-Y File Resampling`.



Input file: C:\Sheldon\TestingOfTesseralPro\Md2+GathEP.sgy

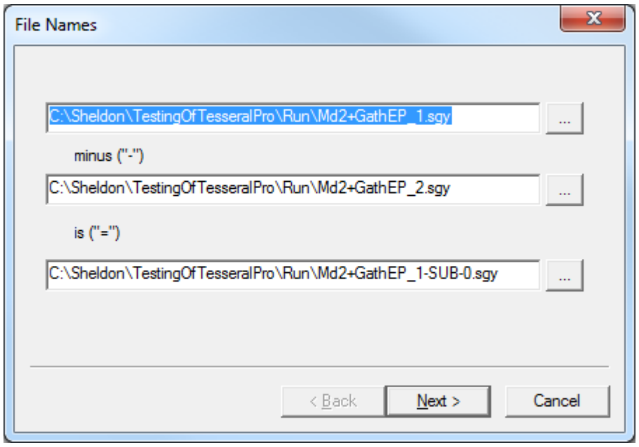
Output File: :tingOfTesseralPro\Md2+GathEP-RESAMPLING.sgy

Input file trace step: 2

Output file trace step: 4

10.1.8 Difference of 2 Seismograms

The command <u>`Run > General Purpose Procedures > Difference of 2 Seismograms`</u> is used to calculate the difference between 2 synthetic gathers created by similar models. It may be used, for example, to evaluate how the perturbations of the model's parameters influences the output gather. It can also be used to obtain the differences between migrated cubes or sections.


File Names

C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP_1.sgy

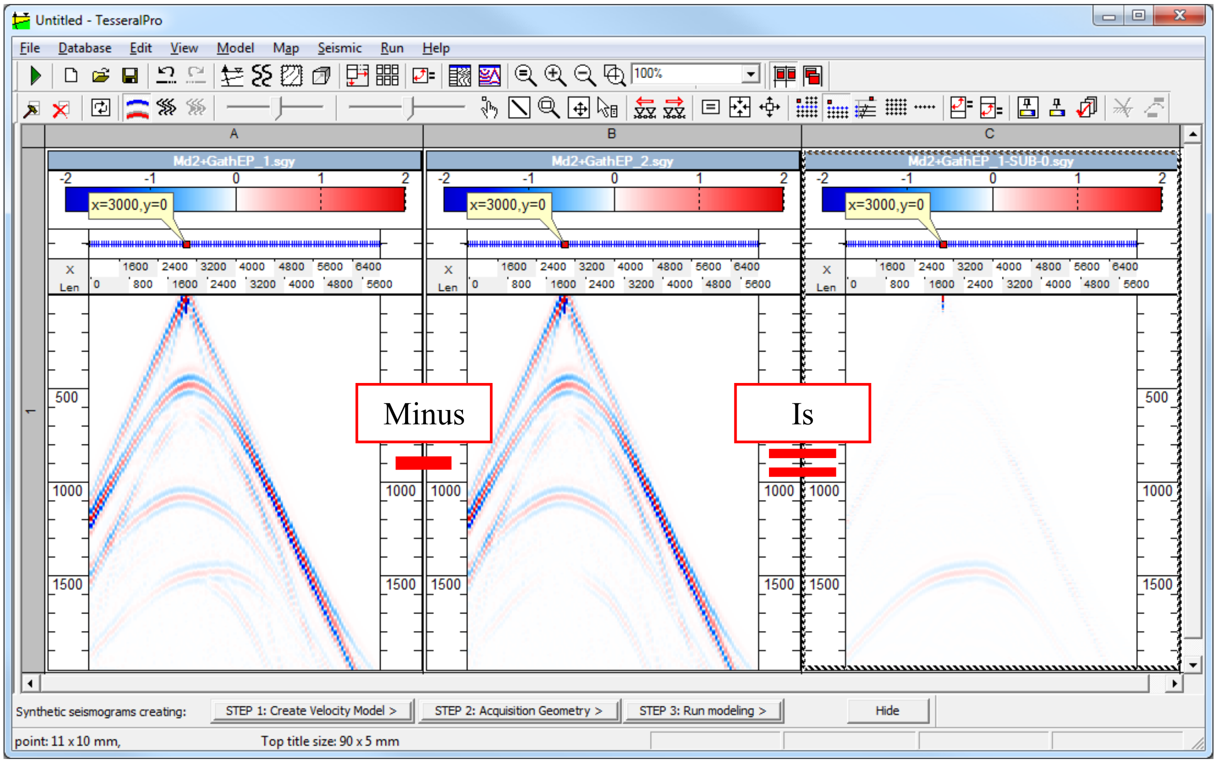
minus ("-")

C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP_2.sgy

is ("=")

C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP_1-SUB-0.sgy

...
< Back
Next >
Cancel


Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
Run
Help
100%
A
B
C
Md2+GathEP_1.sgy
Md2+GathEP_2.sgy
Md2+GathEP_1-SUB-0.sgy
-2
-1
0
1
2
x=3000,y=0
X
Len
500
1000
1500
Minus
Is
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 11 x 10 mm,
Top title size: 90 x 5 mm

10.1.9 Import/Export Traces Coordinates

The coordinates of sources and receivers in the headers of the traces can be exported into a text file using `Run > Seismic  Frame > Export Traces Coordinates`.

The coordinates of sources and receivers in the text file can be imported by using `Run > Seismic Frame > Import Traces Coordinates`.

10.1.10 Write Visible Coordinates to Trace Headers

To write the modified coordinates of traces to the headers of seismic files, the command `Run > Seismic Frame > Write Visible Coordinates to Trace Headers` is used.

In Tesseral Pro, the seismic files can be displayed with transformed/rotated coordinates using the following commands:

- `Seismic > Rotate to Align X Axis along Section Profile`
- `Run > General Purpose Procedures > Import Traces Coordinates` (load coordinates of traces from text files)
- `View > Raw Trace View Window` (in this dialogue box, the trace coordinates can be assigned from non-conventional cells of the trace headers).

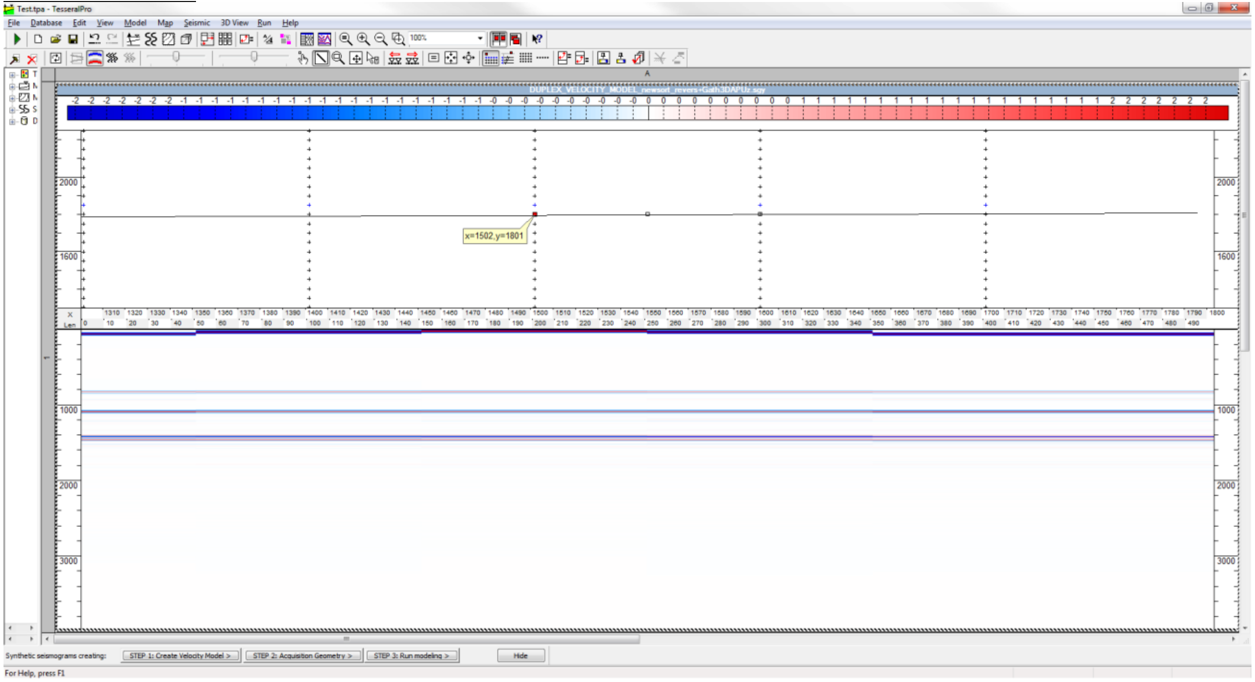
Please see Section *13* for more details.

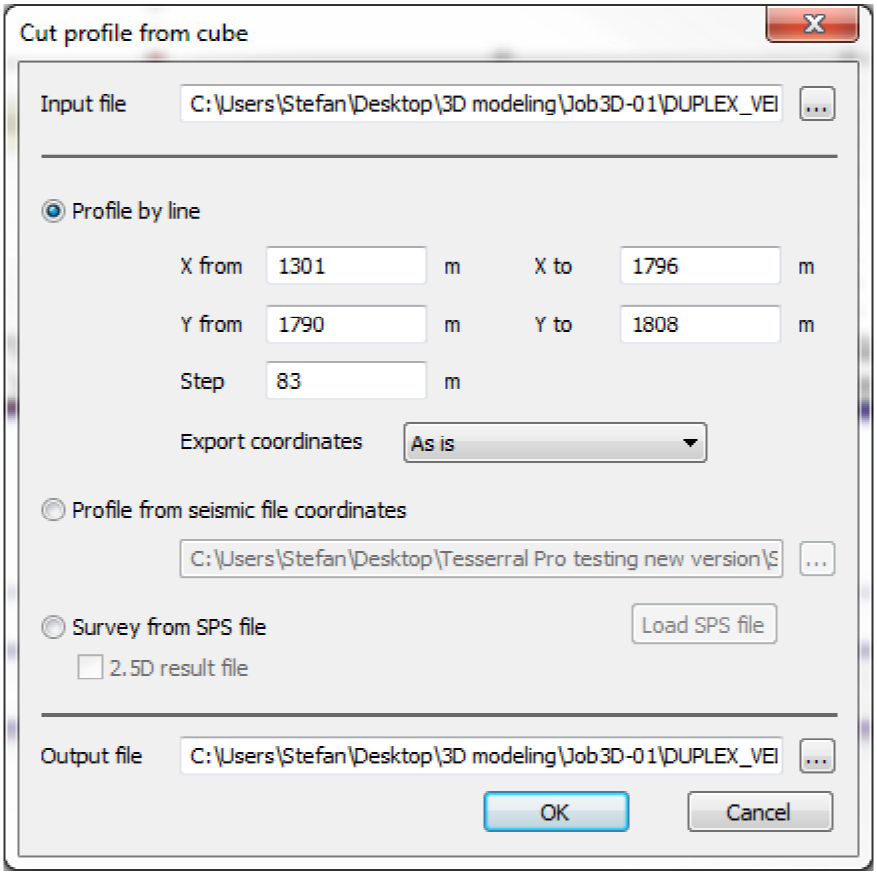
After using the ways mentioned above to change the trace coordinates, the headers of the seismic files are not changed and the information on trace coordinates is written into an additional file `<gather name>.inf` for further use in the Tesseral Pro.

10.1.11 Cut Profile from 3D seismogram

This function is used for the extraction of shot gather traces along a straight line or a polyline from a 3D seismogram.

To access this function please load the 3D seismograms (`File>Load Seismic file`), followed by `Run>General Purpose Procedures>Cut Profile from 3D seismogram`.


Test.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
x=1502,y=1801
2000
1600
1000
3000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1



Cut profile from cube

Input file: C:\Users\Stefan\Desktop\3D modeling\Job3D-01\DUPLEX_VEI

● Profile by line

X from: 1301 m   X to: 1796 m

Y from: 1790 m   Y to: 1808 m

Step: 83 m

Export coordinates: As is

○ Profile from seismic file coordinates

C:\Users\Stefan\Desktop\Tesserral Pro testing new version\S

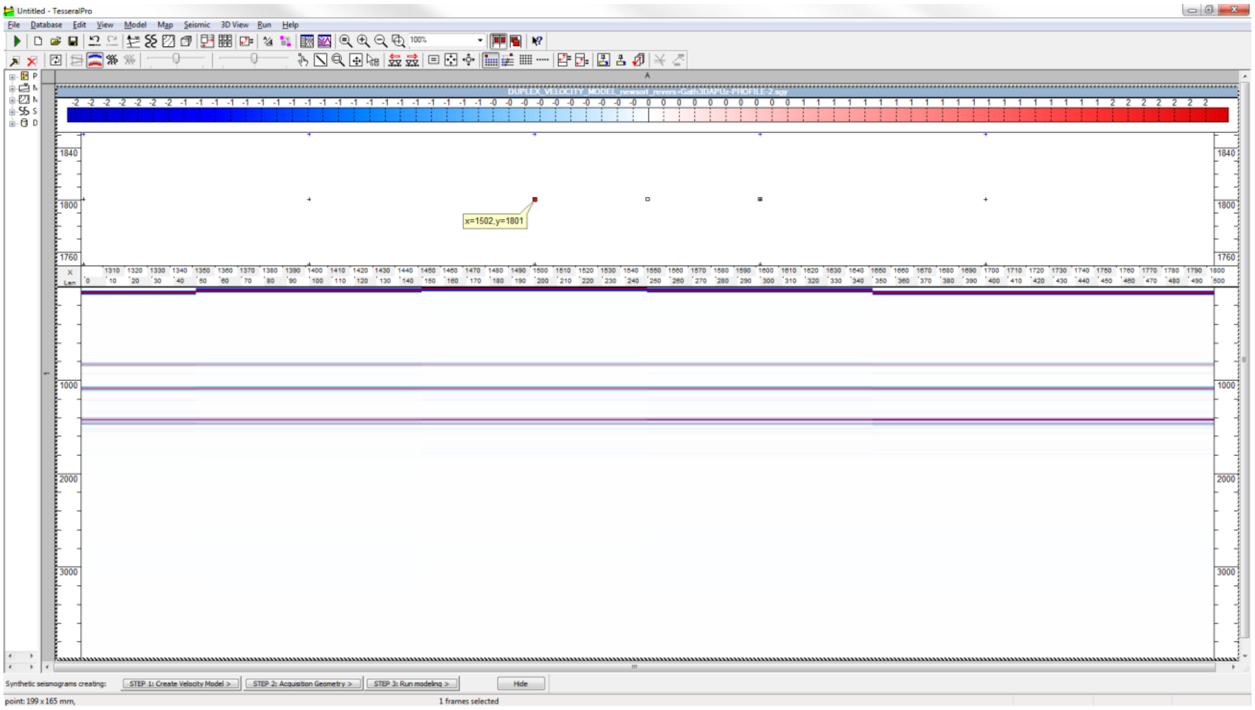
○ Survey from SPS file

☐ 2.5D result file

...
Load SPS file

Output file: C:\Users\Stefan\Desktop\3D modeling\Job3D-01\DUPLEX_VEI

OK
Cancel



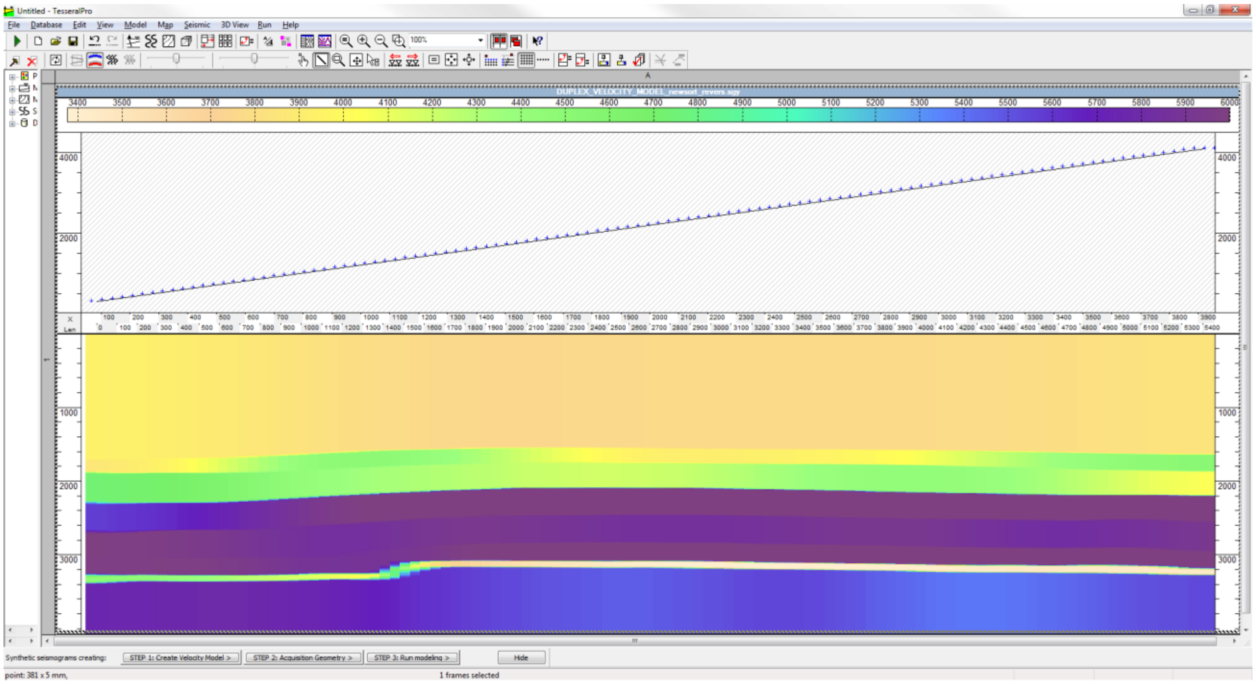
Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
x=1502,y=1801
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 199 x 165 mm,
1 frames selected

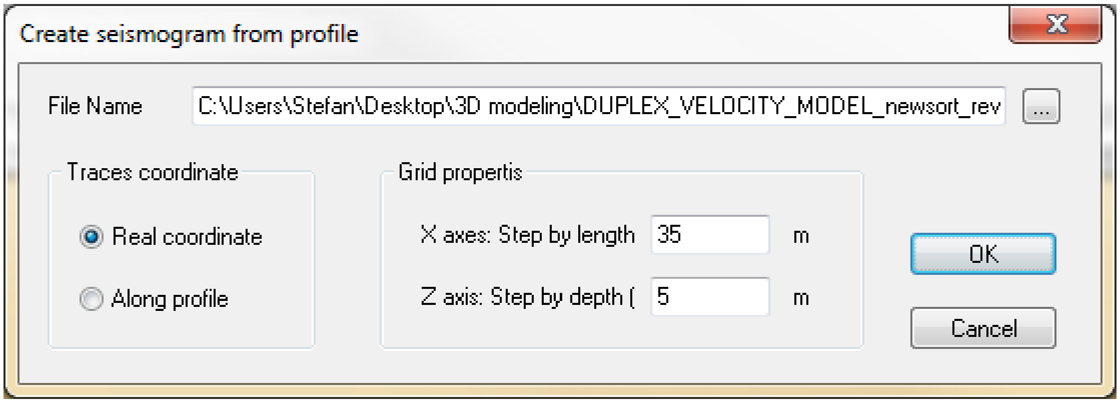
If you would like to extract the coordinates by line, then either specify the `X from`, `X to`, `Y` `from`, `Y to` and `Step` or draw the profile in the seismic frame `Seismic>Edit Mode>Draw Profile` before accessing the `Cut Profile from 3D seismogram` function (for additional information on profiles please see **13.5**).

The traces can be also extracted according to the target survey geometry- `Survey from SPS file` (see Section ***4.7***), or from a text file of traces coordinates - `Profile from Seismic File coordinates`(see section ***10.1.9***).

10.1.12 Export Profile to 2D Seismic File

To export a 2D profile from seismic cube, first of all load the 3D cube (`File>Load Seismic file`), draw the profile in the seismic frame (see *13.5*) followed `Run > Seismic Frame > Export Map to 2D Seismic file`.

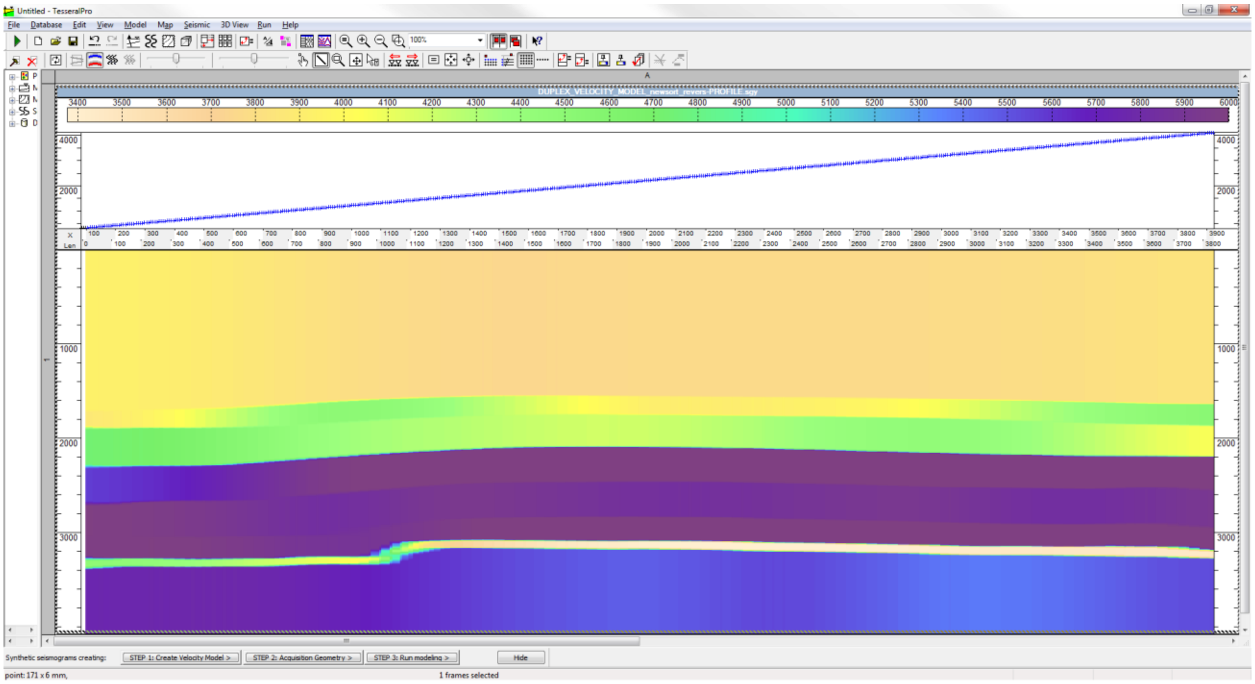

Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
DUPLEX_VELOCITY_MODEL_newsort_revers.sgy
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
1 frames selected


Create seismogram from profile

File Name C:\Users\Stefan\Desktop\3D modeling\DUPLEX_VELOCITY_MODEL_newsort_rev

Traces coordinate
● Real coordinate
○ Along profile

Grid propertis
X axes: Step by length 35 m
Z axis: Step by depth (5 m

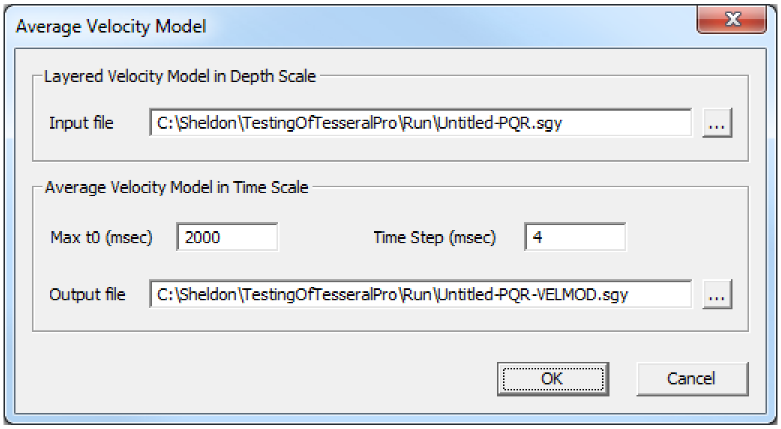

Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
DUPLEX_VELOCITY_MODEL_newsort_revers-PROFILE.sgy
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
5100
5200
5300
5400
5500
5600
5700
5800
5900
6000
4000
2000
1000
2000
3000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 171 x 6 mm,
1 frames selected

10.2 Velocity model

These procedures process the velocity model.

10.2.1 Average Velocities from Model

This is done by the command `Run > Velocity Model > Average Velocities from Model`



Average Velocity Model

Layered Velocity Model in Depth Scale

Input file: C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.sgy

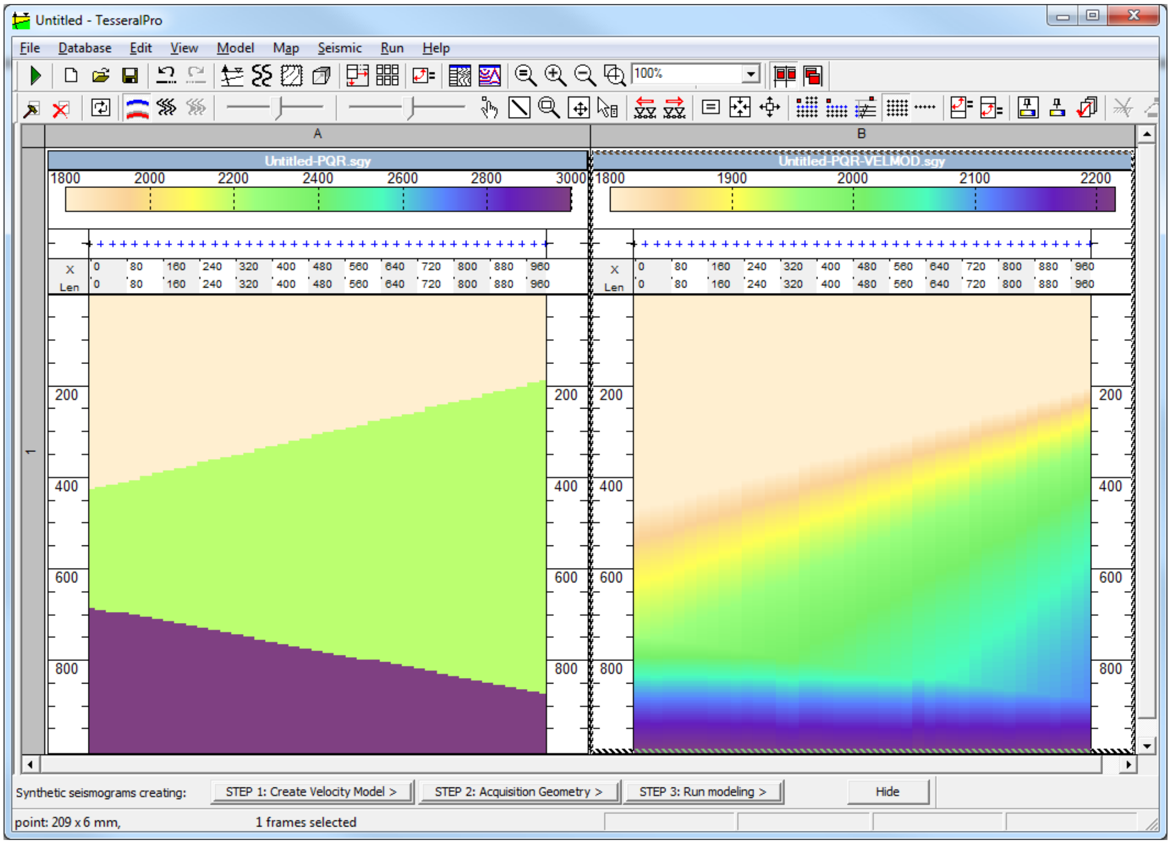
Average Velocity Model in Time Scale

Max t0 (msec): 2000

Time Step (msec): 4

Output file: C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR-VELMOD.sgy

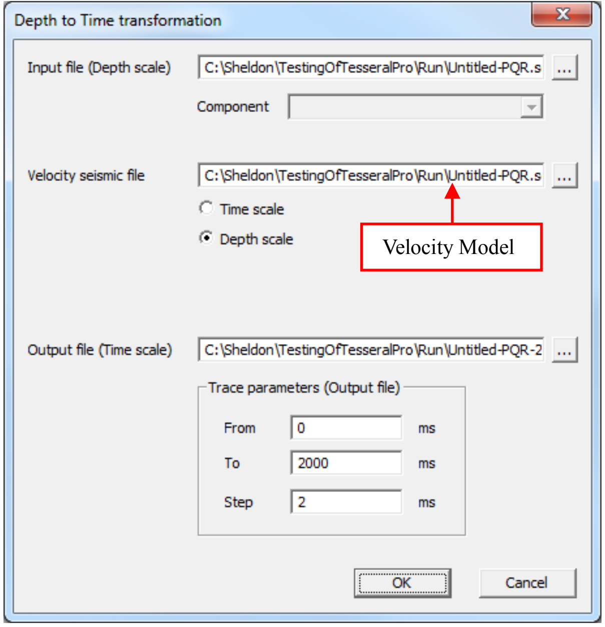
The `Input file` is the layered velocity model, which may be obtained from the Model Frame by the command `Model > Export to Seismic Format (SEG-Y, TGR)`.



Untitled - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
A
B
Untitled-PQR.sgy
1800 2000 2200 2400 2600 2800 3000
Untitled-PQR-VELMOD.sgy
1800 1900 2000 2100 2200
X
Len
0 80 160 240 320 400 480 560 640 720 800 880 960
200
400
600
800
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 209 x 6 mm,
1 frames selected

10.2.2 Depth-to-Time/Time-to-Depth conversion

The command `Run > Velocity Model > Depth to time transformation` transforms migrated sections (cubes) from depth domain to time domain.



Depth to Time transformation

Input file (Depth scale): C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.s

Component:

Velocity seismic file: C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR.s

○ Time scale
● Depth scale

Velocity Model

Output file (Time scale): C:\Sheldon\TestingOfTesseralPro\Run\Untitled-PQR-2

Trace parameters (Output file)

From: 0 ms
To: 2000 ms
Step: 2 ms

NOTE: `Velocity seismic file` is the layered velocity model, which may have been obtained from the Model Frame by the command `Model > Export to Seismic Format (SEG-Y, TGR)` (please see Section *12.3.1* for details).

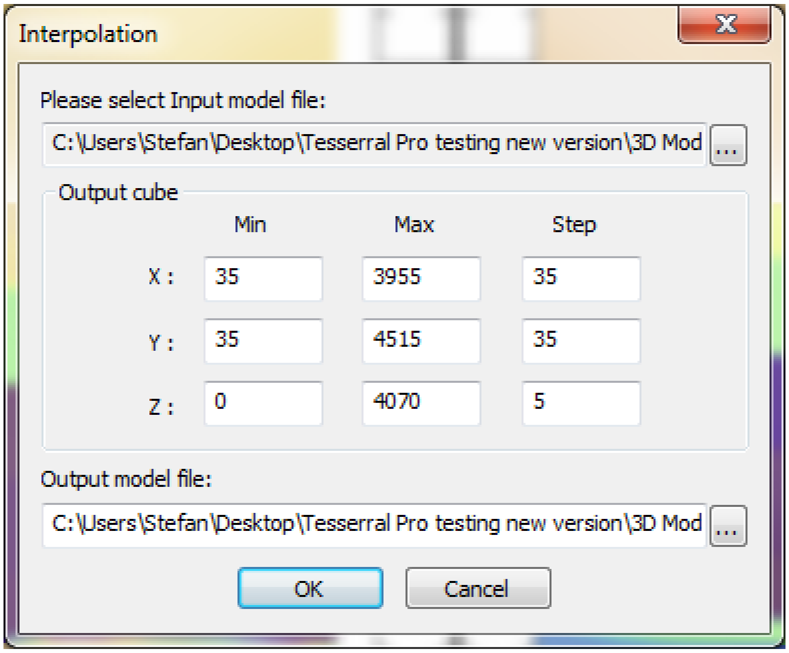
The command `Run > Velocity Model > Time to Depth Transformation` transforms the velocity model from time domain to the depth domain.

NOTE: `Velocity seismic file` is the file of layered model grid in time domain. It may have been created from the depth model by using the transformation `Depth to Time Transformation`. It means that, in the procedure `Depth to Time Transformation`, if the `Input file` and `Velocity seismic file` represent the velocity model, the `Output file` will be the same model but in time domain.

10.2.3 3D Interpolation

With the help of `Run>Velocity Model> Interpolation`, the user can resample the grid step for any 3D SGY cube by interpolating between adjacent grids. This functions can be used if the user wants to generate a 3D SGY cube with a grid spacing matching the stacking bin spacing of the 3D survey.

To implement this this function, first of all you will need to load the 3D SGY: `File>Load Seismic File` followed by `Run>Velocity Model>Interpolation`.



Please select Input model file: C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D Mod

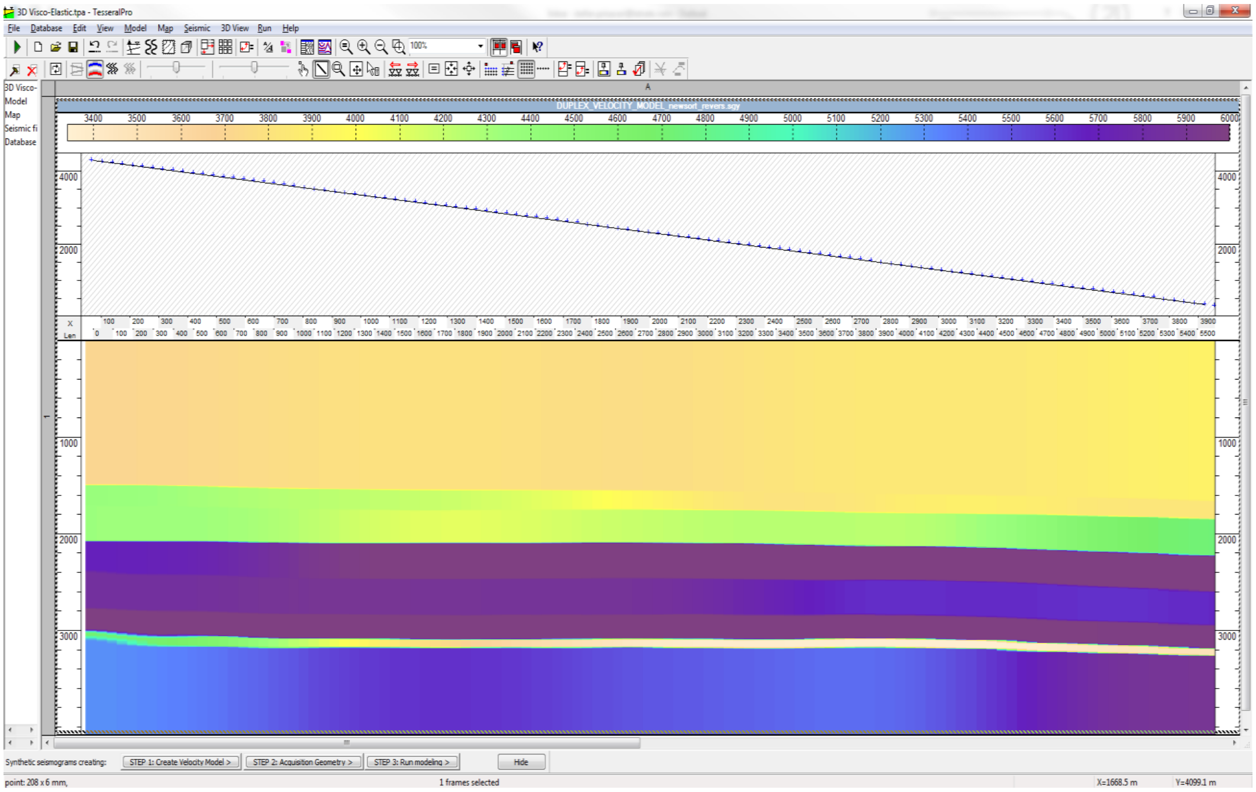
Output cube

	Min	Max	Step
X :	35	3955	35
Y :	35	4515	35
Z :	0	4070	5

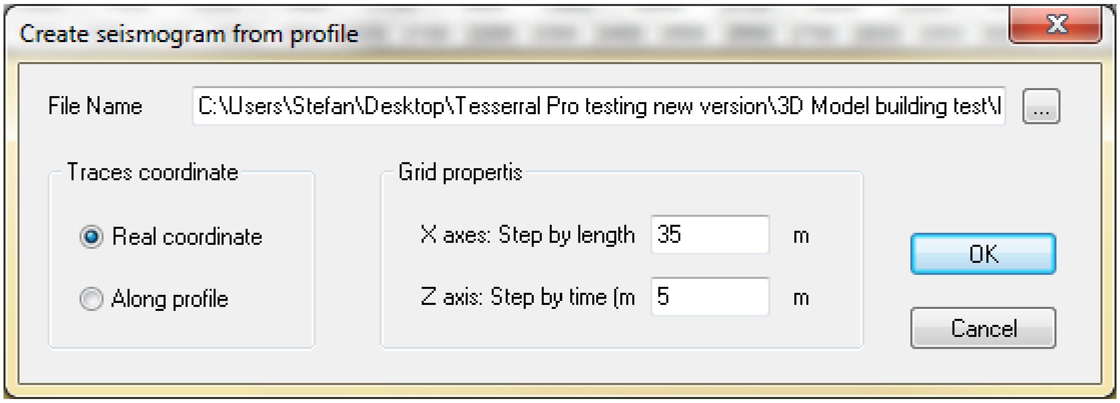
Output model file: C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D Mod

Reassign a new grid `Step` along X, Y, Z and click `OK`. The generated cube will have the new reassigned grid step, as you can see in the `Raw trace view`.

If a 2D section with a new reassigned grid step has to be either generated from an existing 2D SGY file or extracted from a 3D SGY cube, you will first have to load the appropriate SGY file (`File>Load seismic file`) and then draw a profile in the seismic frame using `Seismic >Edit mode>Draw Profile Mode`...


3D Visco-Elastic.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
1 frames selected

…followed by `Run>Seismic Frame>Export Map to 2D Seismic File.`


Create seismogram from profile

File Name C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D Model building test\I

Traces coordinate

● Real coordinate

○ Along profile

Grid propertis

X axes: Step by length 35 m

Z axis: Step by time (m 5 m

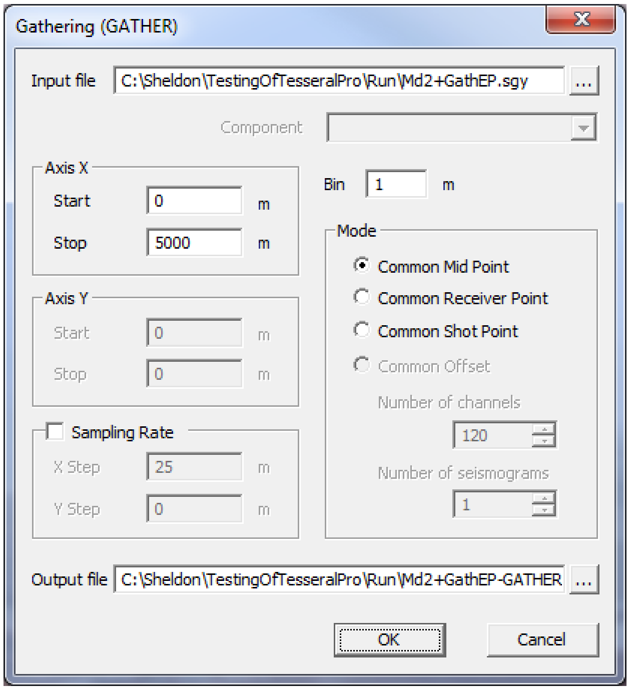
Reassign the new grid step along X and Z and click `OK`.

10.3 Pre-Processing

These procedures are for preliminary processing.

10.3.1 Gathering

The procedure is intended for extracting gathers by the criteria of common shot point, common midpoint or common receiver point or obtaining gathers with common offsets. The procedure applies for both 2D and 3D gathers. Use the command `Run > Pre-Processing > Gathering (GATHER)`.



Input file C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP.sgy

Component

Axis X
Start 0 m
Stop 5000 m

Axis Y
Start 0 m
Stop 0 m

☐ Sampling Rate
X Step 25 m
Y Step 0 m

Bin 1 m

Mode
● Common Mid Point
○ Common Receiver Point
○ Common Shot Point
○ Common Offset

Number of channels 120

Number of seismograms 1

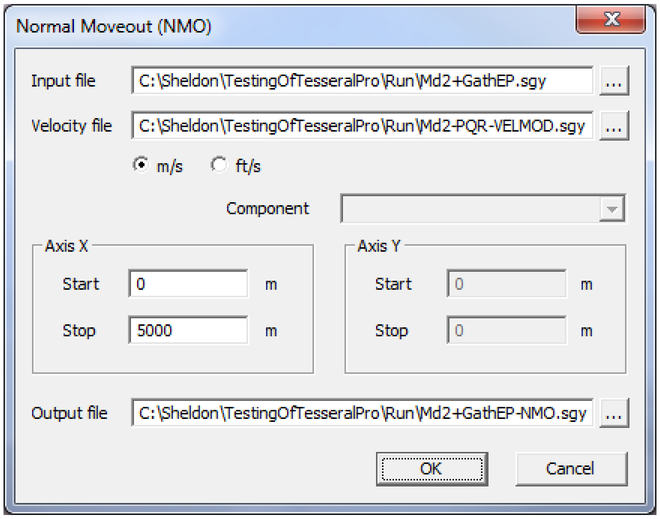
Output file C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-GATHER

10.4 Stack (Time domain)

The procedure is for time-domain stacking.

10.4.1 Kinematic corrections (Normal Moveout)

The `Normal Moveout` procedure applies kinematic corrections to gathers of various type, e.g., common midpoint gathers, common receiver gathers (Gathering program) and common shot gathers. The result is the time domain gathers after NMO correction. Use the command `Run > Stack (Time domain) > Normal Moveout (NMO)`.



Normal Moveout (NMO)

Input file C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP.sgy

Velocity file C:\Sheldon\TestingOfTesseralPro\Run\Md2-PQR-VELMOD.sgy

● m/s ○ ft/s

Component

Axis X

Start 0 m

Stop 5000 m

Axis Y

Start 0 m

Stop 0 m

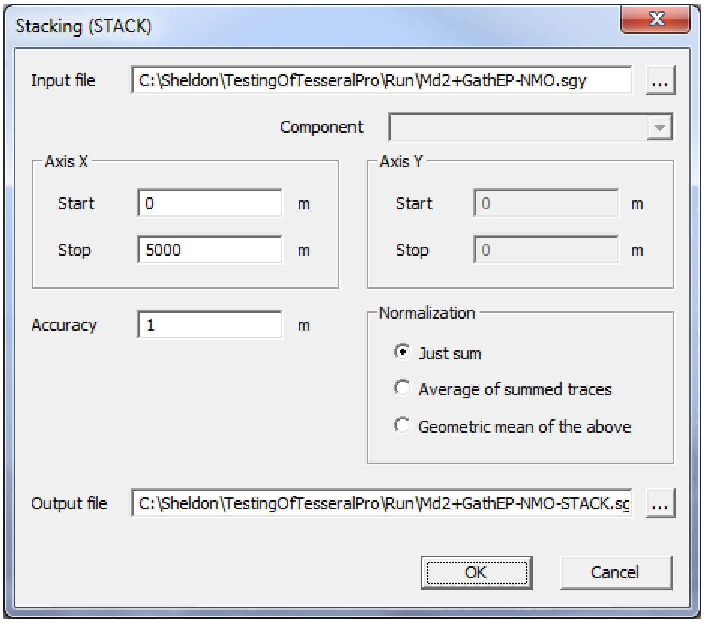
Output file C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-NMO.sgy

The average velocity model (parameter `Velocity file`) may be created from layered depth velocity model by the command `Run > Velocity Model > Average Velocities from Model`. To obtain a time slice of the subsurface image after Normal Moveout correction, use the `Stacking` procedure.

10.4.2 Stacking

The procedure `Stacking` is meant for stacking traces with a common coordinate after the `Normal Moveout`.

Before applying the `Staking` procedure, the kinematic correction needs to be applied using the `Normal Moveout` procedure. The command `Run > Stack (Time domain) > Stacking (STACK)` is used.


Stacking (STACK)

Input file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-NMO.sgy

Component:

Axis X
Start: 0 m
Stop: 5000 m

Axis Y
Start: 0 m
Stop: 0 m

Accuracy: 1 m

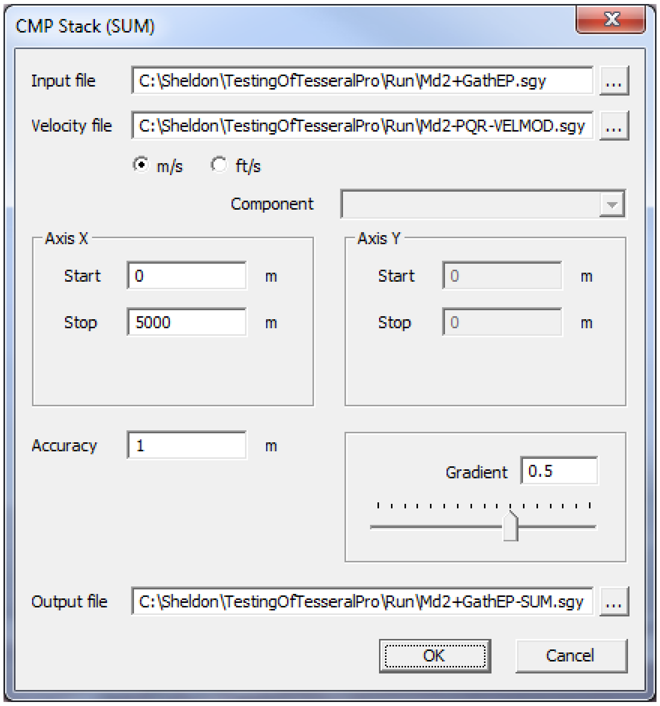
Normalization
● Just sum
○ Average of summed traces
○ Geometric mean of the above

Output file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-NMO-STACK.sg

`Accuracy` is the bin size used for stacking common depth point traces.

10.4.3 CMP Stack

This is used for direct creation of time section by common midpoints (midpoint stacks) without applying the procedures `Normal Moveout` and `Stacking`. The `CMP Stack` procedure uses the medium's average velocity (parameter `Velocity file`). The command `Run > Stack (Time domain) > CMP Stack (SUM)` is used.



CMP Stack (SUM)

Input file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP.sgy

Velocity file: C:\Sheldon\TestingOfTesseralPro\Run\Md2-PQR-VELMOD.sgy

● m/s ○ ft/s

Component:

Axis X
Start: 0 m
Stop: 5000 m

Axis Y
Start: 0 m
Stop: 0 m

Accuracy: 1 m

Gradient: 0.5

Output file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathEP-SUM.sgy

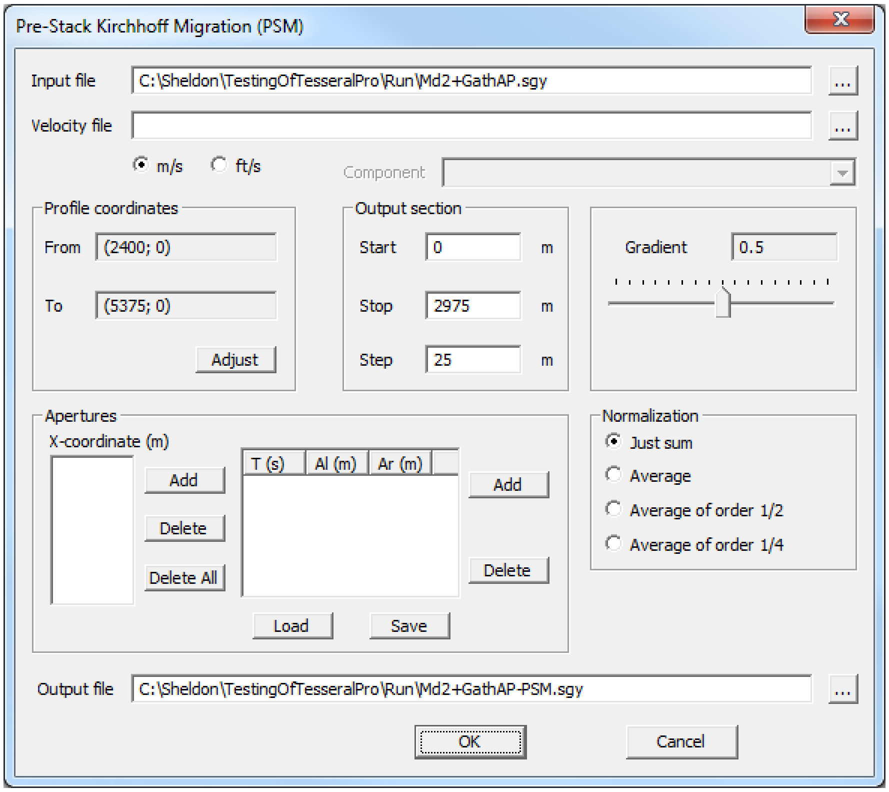
The average velocity model may be created from layered depth velocity model by the command `Run > Velocity Model > Average Velocities from Model`. The `Gradient` parameter is for NMO stretch mute.

10.5 2D/3D Migration

Procedures for the migration of time-domain 2D gathers

10.5.1 Time Pre-Stack Kirchhoff Migration

The procedure is for creating migration image directly from gathers without creating CMP time section or post-stack migration. The command `Run > 2D Migration (Time domain) > Time Pre-Stack Kirchhoff Migration (PSM)` is used.


Pre-Stack Kirchhoff Migration (PSM)
Velocity file
...
Component
Profile coordinates
Adjust
Output section
Apertures
X-coordinate (m)
Add
Delete
Delete All
T (s)
Al (m)
Ar (m)
Add
Delete
Load
Save
Normalization
○ Average
○ Average of order 1/2
○ Average of order 1/4
OK
Cancel

Input file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathAP.sgy

● m/s ○ ft/s

Profile coordinates: From (2400; 0) To (5375; 0)

Output section: Start 0 m, Stop 2975 m, Step 25 m

Gradient 0.5

Normalization: ● Just sum

Output file: C:\Sheldon\TestingOfTesseralPro\Run\Md2+GathAP-PSM.sgy

This migration needs the time-domain average velocity model as input, which may be obtained by using the commands `Model > Export to Seismic Format (SEG-Y, TGR)` and then `Run > Velocity Model > Average Velocities from Model`. Users can specify velocity measurement units in the model (`m/s` or `ft/s`).

If the migration aperture is not specified, the program may use the default values. To specify the apertures explicitly, the buttons in the `Apertures` group are used: `Add` , `Delete`, `Delete All`, `Load` (from a file), and `Save` (to a file).

The migrated section is specified by the parameter `Profile Coordinates` (whose direction is specified by the `Adjust` button) and `Output Section` (size and step along the profile). These are mandatory parameters to be input by the user.

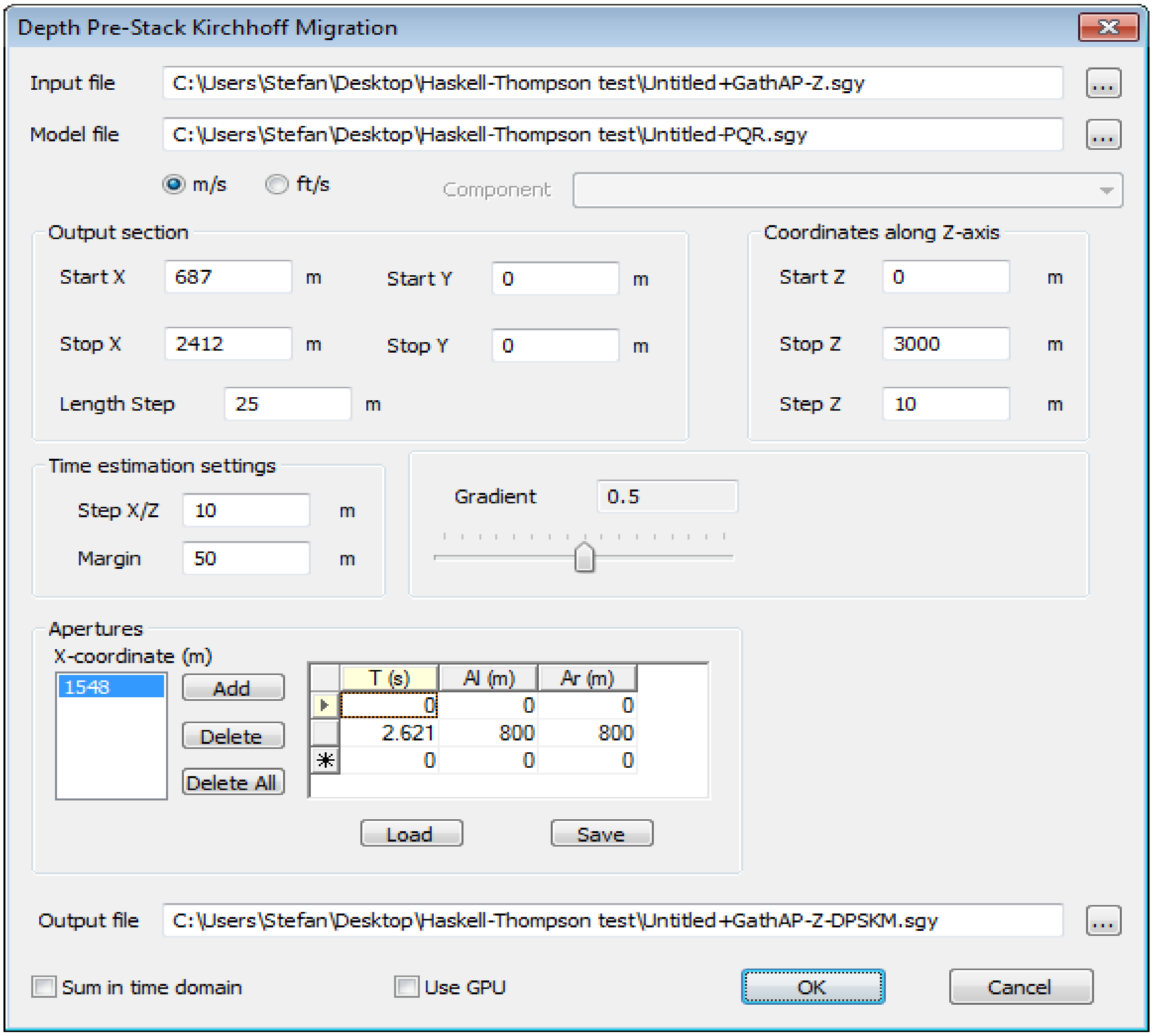
The signal stretching is limited by `Gradient`, whose default value is 0.5. If the gradient is too small, the images will be too “spread”; if the gradient is too big, some objects may disappear.

The result may be normalized (in this case, the noise and the low signals will be amplified). Usually normalization is not applied (the `Just sum` option).

The migrated time section is saved to the `Output file`. To transform it from time scale to the depth domain, use the command `Run > Velocity Model > Time to Depth Transformation`.

10.5.2 Depth Pre-Stack Kirchhoff Migration

The command Run > 2D Migration (Depth domain) > Depth Pre-Stack Kirchhoff Migration (DPSKM) performs the Depth Pre-Stack Kirchhoff Migration. The result is in depth domain. To transform it to time domain, use the command Run > Velocity Model > Depth to time Transformation.



Input file: C:\Users\Stefan\Desktop\Haskell-Thompson test\Untitled+GathAP-Z.sgy

Model file: C:\Users\Stefan\Desktop\Haskell-Thompson test\Untitled-PQR.sgy

● m/s ○ ft/s

Start X: 687 m
Start Y: 0 m
Stop X: 2412 m
Stop Y: 0 m
Length Step: 25 m

Start Z: 0 m
Stop Z: 3000 m
Step Z: 10 m

Step X/Z: 10 m
Margin: 50 m

Gradient: 0.5

X-coordinate (m): 1548

T (s)	Al (m)	Ar (m)
0	0	0
2.621	800	800
0	0	0

Output file: C:\Users\Stefan\Desktop\Haskell-Thompson test\Untitled+GathAP-Z-DPSKM.sgy

☐ Sum in time domain ☐ Use GPU

For migration, the layered velocity model has to be in depth domain, which may be obtained by using the menu command Model > Export to Seismic Format (SEG-Y, TGR). The velocity measurement units in the model can be specified (m/s or ft/s).

If the migration aperture is not specified, the program uses the default values. To specify the apertures explicitly, the buttons in the Apertures group are used: Add, Delete, Delete All, Load (from a file), and Save (to a file), each of which invoke a simple dialogue box.

The migrated section is based on the 2D data. The size of the processing area and the corresponding step along the profile (in X direction) is assigned in Coordinates along X-axis.

The signal stretching is limited by the Gradient, whose default value is 0.5. If the gradient is too small, the images will be too "spread"; if the gradient is too big, some intervals may disappear.

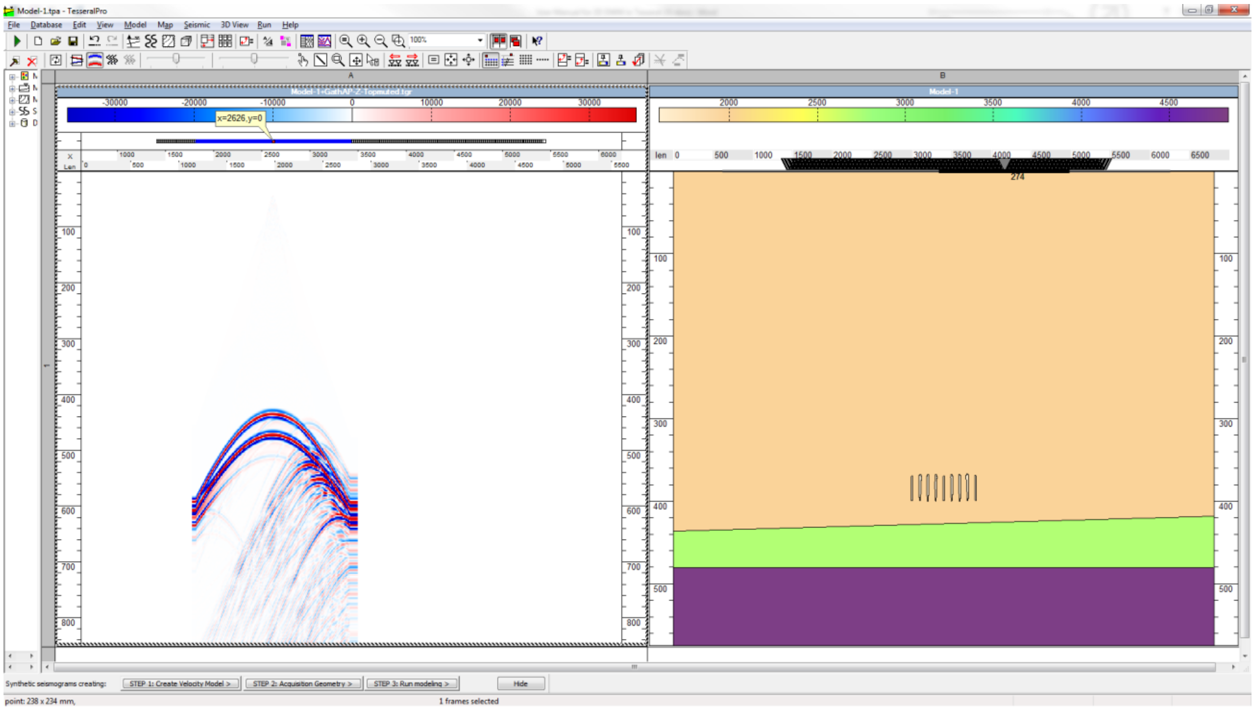
This program uses the eikonal solver to compute time fields. Discretization of the computation grid is specified by `STEP X/Z` in the `Time estimation settings` group. The additional frame (`Margin`) gives the option of removing the influence of the edge effects. It is recommended to set it to 5 – 10 grid steps.

10.5.3 2D Duplex Wave Migration

Duplex Wave Migration (DWM) is a newly developed technology capable of imaging events with dips 60 ˚ to 90 ˚. Duplex waves are strong enough to be used for geological purposes.

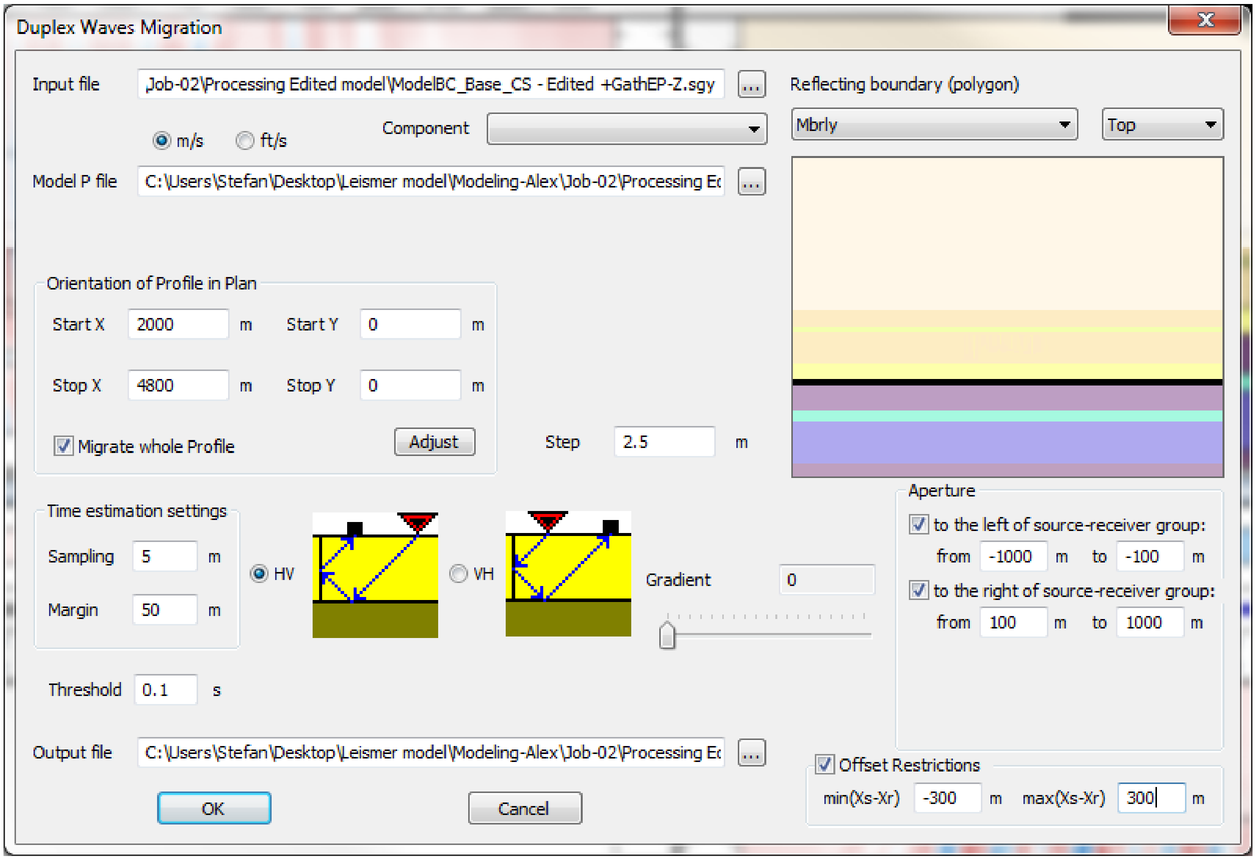
Duplex waves get reflected twice: from a sub-horizontal surface followed by reflection from the sub-vertical surface or vice versa. 2D DWM supports only PPP type reflections.

Before running 2D DWM, the user first of all needs to import the 2D synthetic seismograms in SGY format, as well as the 2D model which generated these seismograms. This is done by clicking on `File>Open` in the upper menu.


Model-1.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Model-1-GathAP-Z-Topmuted.tgr
Model-1
x=2626, y=0
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 238 x 234 mm,
1 frames selected

Once the model and its respective seismograms have been loaded the user can then proceed to the DWM settings tab by clicking `Run>2D Migration (Depth domain)>Duplex`

`Wave Migration.`



Input file: Job-02\Processing Edited model\ModelBC_Base_CS - Edited +GathEP-Z.sgy

● m/s ○ ft/s

Component:

Model P file: C:\Users\Stefan\Desktop\Leismer model\Modeling-Alex\Job-02\Processing Ec

Reflecting boundary (polygon): Mbrly, Top

Orientation of Profile in Plan

Start X: 2000 m
Start Y: 0 m
Stop X: 4800 m
Stop Y: 0 m

☑ Migrate whole Profile, Adjust

Step: 2.5 m

Time estimation settings

Sampling: 5 m
Margin: 50 m

● HV ○ VH

Gradient: 0

Threshold: 0.1 s

Aperture

☑ to the left of source-receiver group: from -1000 m to -100 m

☑ to the right of source-receiver group: from 100 m to 1000 m

☑ Offset Restrictions

min(Xs-Xr): -300 m
max(Xs-Xr): 300 m

Output file: C:\Users\Stefan\Desktop\Leismer model\Modeling-Alex\Job-02\Processing Ec

In the `Duplex Wave Migration` tab, the user will need to double check that the `Input file` is the correct SGY file, containing the appropriate synthetic seismograms and also specify the name as well as the location of the `Output File` (i.e. the migrated seismic section).

The DWM algorithm is designed to image the DW energy that will arrive at a time greater than that of the primary base boundary. A beam tube construction eliminates the migration noise that would result from the base boundary primary reflections in the migration summation. For this reason in the `Model P file`, the user needs to upload the SGY P wave velocity model (in depth domain), that contains just the horizontal and the sub-horizontal geological structures, without the vertical heterogeneities, that will ultimately be imaged by this method. The depth model can easily be generated by going `Model>Export to Seismic Format(SGY)` in the upper menu.

The user will also need to select the `Reflecting boundary(polygon`) or base boundary for duplex waves reflection. For exactly this reason the imported 2D model MUST at the very least have the base boundary as a polygon (see section ***5***). The base boundary should of course be below the sub-vertical heterogeneities that need to be imaged by DWM.

The migrated section is specified by the parameters `Start X` and `Stop X` as well as `Start Y` and `Stop Y` in the `Profile Coordinates` tab (whose direction can also be specified by the `Adjust` button) . The parameter `Step` is recommended to be identical to the grid step that was used for forward modeling.

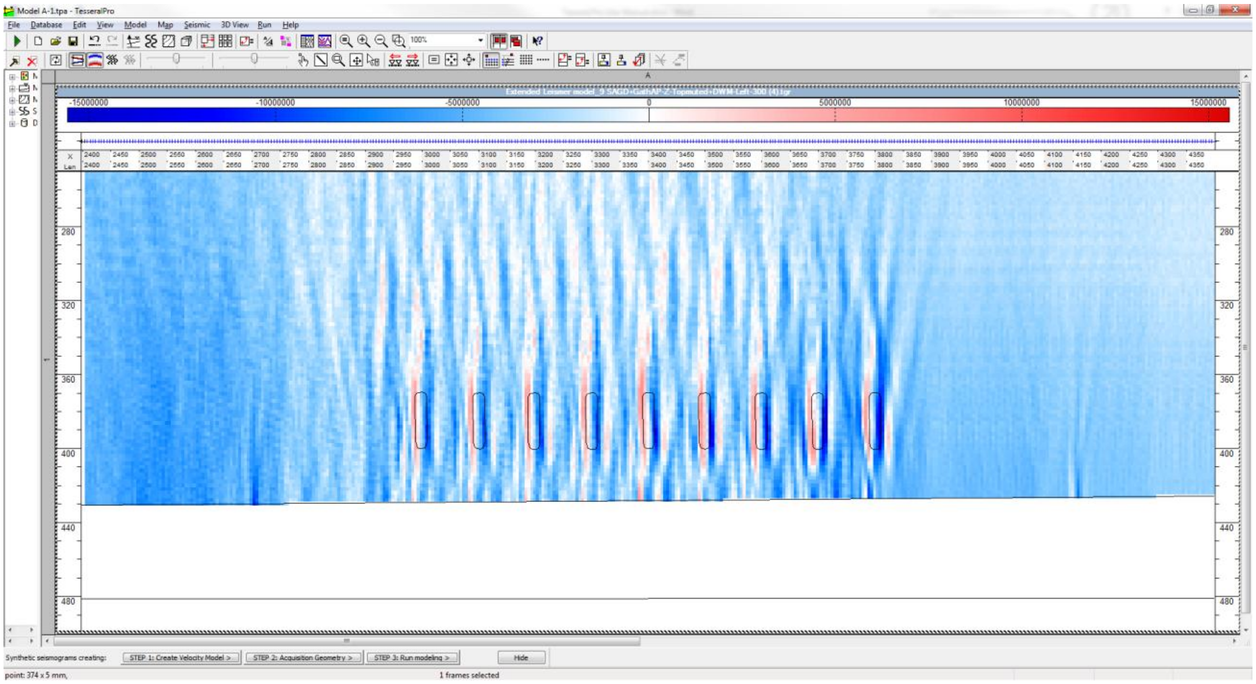
This program uses the eikonal solver to compute time fields. Discretization of the computation grid along the X and Z axis is specified by `Step` in the `Time estimation settings` group.

In the `Aperture` tab the migration aperture for duplex waves is assigned. The user can specify a left aperture by specifying the distance `to the left of the source receiver group` or a right aperture to the `to the right of the source receiver group`. Also, a symmetric aperture can be assigned by specifying both. The left aperture is to the left of the leftmost source/receiver in the observation system, while the right aperture is to the right of the rightmost source/receiver.

The signal stretching is limited by `Gradient`, whose default value is 0. If the gradient is too small, the images will be too “spread”; if the gradient is too big, some objects may disappear. There are two possible orders of reflections- `HV` and `VH` (i.e. reflection from the horizontal boundary followed by the reflection from the sub vertical boundary (`HV`) and vice versa (`VH`).

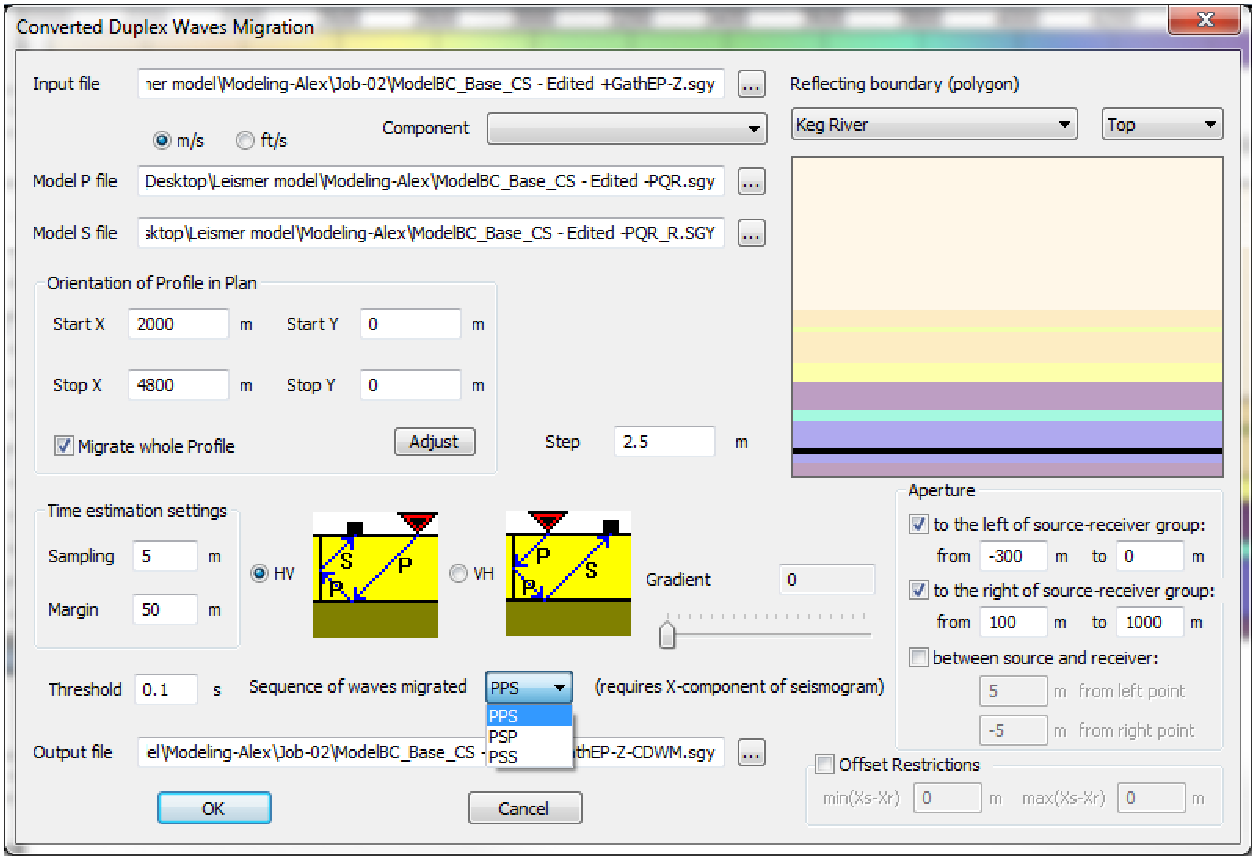
For offset restrictions use `min(Xr-Xs`) and `max(Xr-Xs`) . Only the specified traces will be processed by DWM, the rest will be omitted. Please note that the specified values can be negative for traces to the left of the source and positive for traces to the right of the source.

`Threshold` is used for supressing the shot gathers by a particular time interval in order to eliminate the migration noise associated with the primary reflection wave arrival.


Model A-1.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
Extended Leismer model_9 SAGD+GathAP-Z-Topmuted+DWM-Left-300 (4).tgr
-15000000
-10000000
-5000000
0
5000000
10000000
15000000
X
Len
2400 2450 2500 2550 2600 2650 2700 2750 2800 2850 2900 2950 3000 3050 3100 3150 3200 3250 3300 3350 3400 3450 3500 3550 3600 3650 3700 3750 3800 3850 3900 3950 4000 4050 4100 4150 4200 4250 4300 4350
280
320
360
400
440
480
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 374 x 5 mm,
1 frames selected

10.5.4 2D Converted Duplex Wave Migration

Converted Duplex Wave Migration can be applied to PPS, PSS and PSP type duplex wave, as you can see in the CDWM window. And depending on the type of converted duplex waves, you may be required to use the X component (i.e. horizontal particle velocity) of the synthetic seismograms and also load the S Model File.



Converted Duplex Waves Migration

Input file: ıer model\Modeling-Alex\Job-02\ModelBC_Base_CS - Edited +GathEP-Z.sgy

● m/s ○ ft/s

Component:

Model P file: Desktop\Leismer model\Modeling-Alex\ModelBC_Base_CS - Edited -PQR.sgy

Model S file: sktop\Leismer model\Modeling-Alex\ModelBC_Base_CS - Edited -PQR_R.SGY

Reflecting boundary (polygon): Keg River, Top

Orientation of Profile in Plan

Start X: 2000 m, Start Y: 0 m

Stop X: 4800 m, Stop Y: 0 m

☑ Migrate whole Profile

Step: 2.5 m

Time estimation settings

Sampling: 5 m

Margin: 50 m

● HV ○ VH

Gradient: 0

Threshold: 0.1 s

Sequence of waves migrated: PPS (requires X-component of seismogram)

Output file: el\Modeling-Alex\Job-02\ModelBC_Base_CS - ıthEP-Z-CDWM.sgy

Aperture

☑ to the left of source-receiver group: from -300 m to 0 m

☑ to the right of source-receiver group: from 100 m to 1000 m

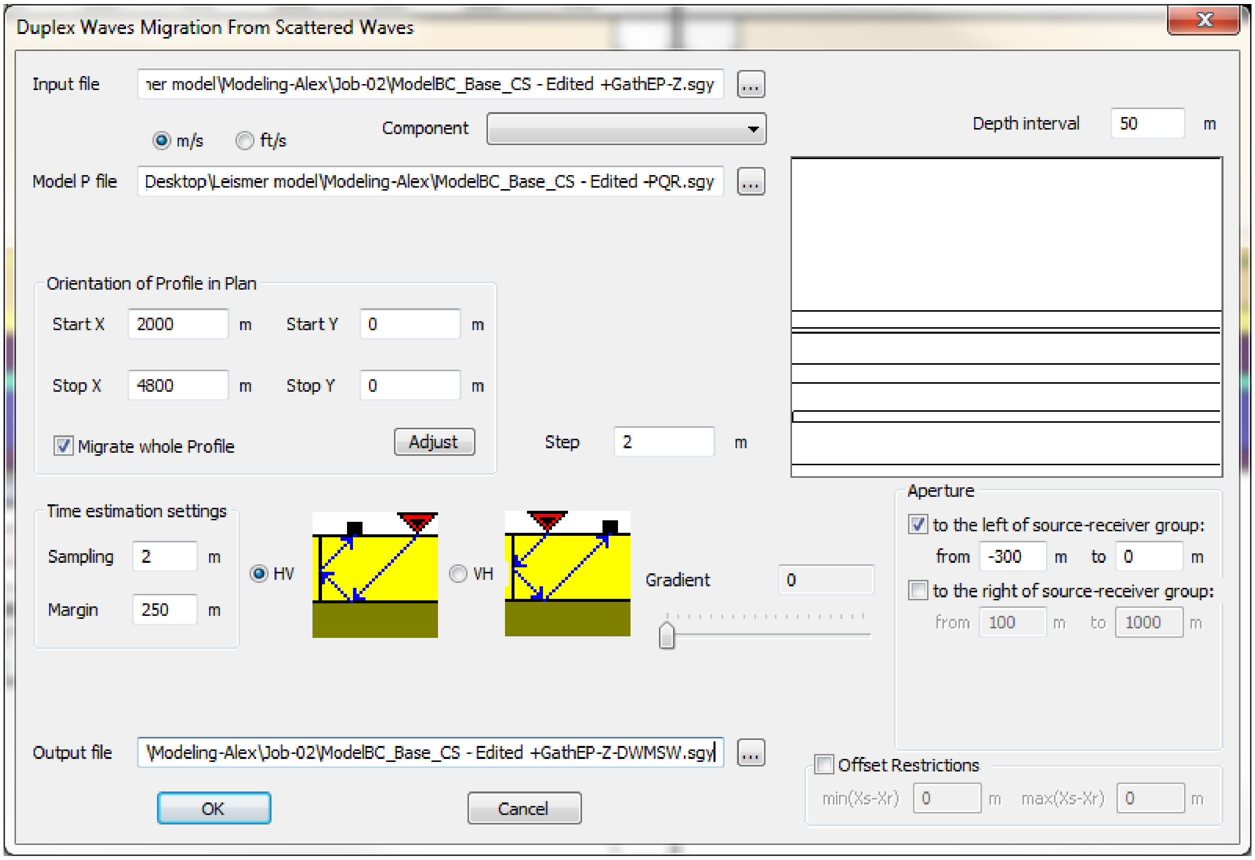
☐ between source and receiver: 5 m from left point; -5 m from right point

☐ Offset Restrictions: min(Xs-Xr) 0 m, max(Xs-Xr) 0 m

The user also the option of specifying internal apertures (i.e. between source and receiver). This option should be used for the imaging of transmitted converted waves.

10.5.5 2D Duplex Wave Migration from Scattered Waves

The use DWM for scattered waves is most suitable for targets below the last strong reflecting horizon, such as faults, salt domes and other steep structure flanks.



Duplex Waves Migration From Scattered Waves

Input file: er model\Modeling-Alex\Job-02\ModelBC_Base_CS - Edited +GathEP-Z.sgy

● m/s ○ ft/s

Component:

Depth interval: 50 m

Model P file: Desktop\Leismer model\Modeling-Alex\ModelBC_Base_CS - Edited -PQR.sgy

Orientation of Profile in Plan

Start X: 2000 m Start Y: 0 m

Stop X: 4800 m Stop Y: 0 m

☑ Migrate whole Profile

Step: 2 m

Time estimation settings

Sampling: 2 m

Margin: 250 m

● HV ○ VH

Gradient: 0

Aperture

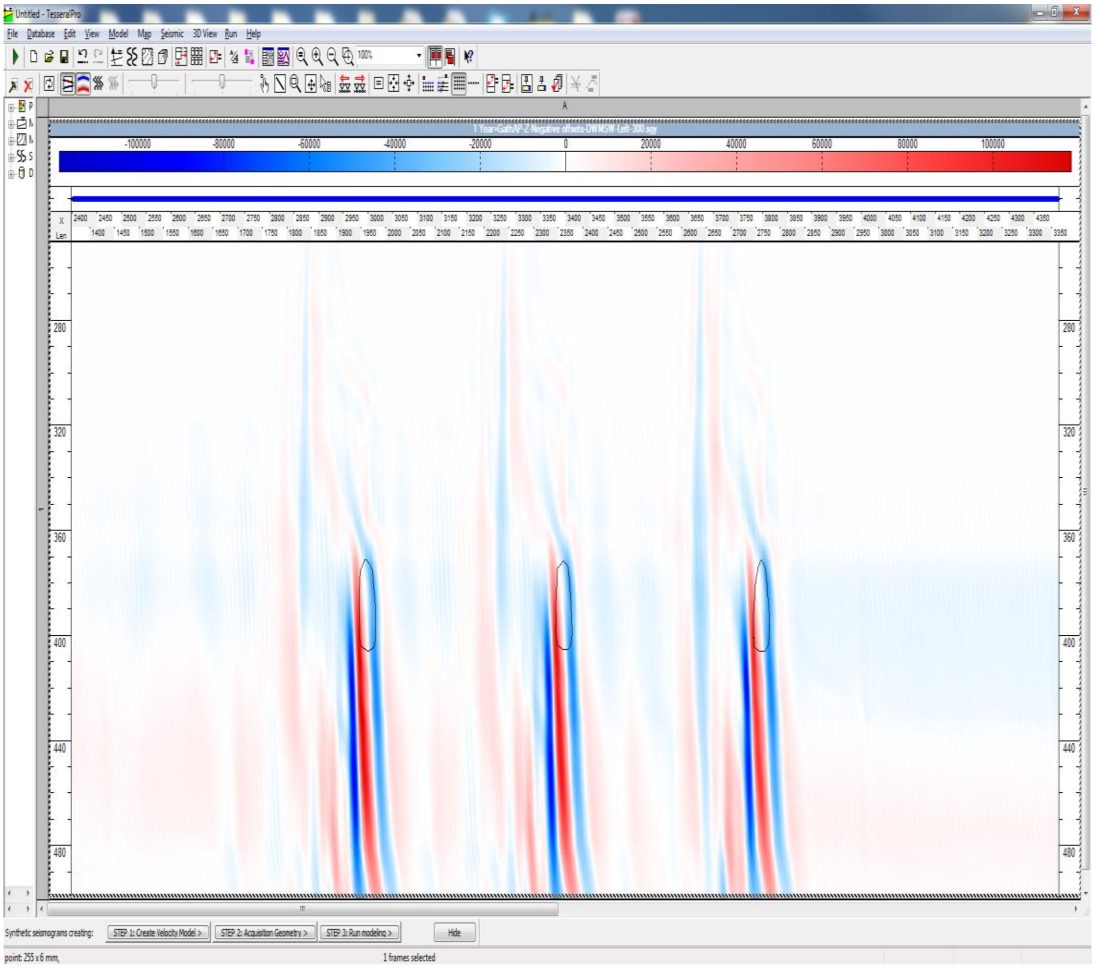
☑ to the left of source-receiver group: from -300 m to 0 m

☐ to the right of source-receiver group: from 100 m to 1000 m

☐ Offset Restrictions: min(Xs-Xr) 0 m max(Xs-Xr) 0 m

Output file: \Modeling-Alex\Job-02\ModelBC_Base_CS - Edited +GathEP-Z-DWMSW.sgy

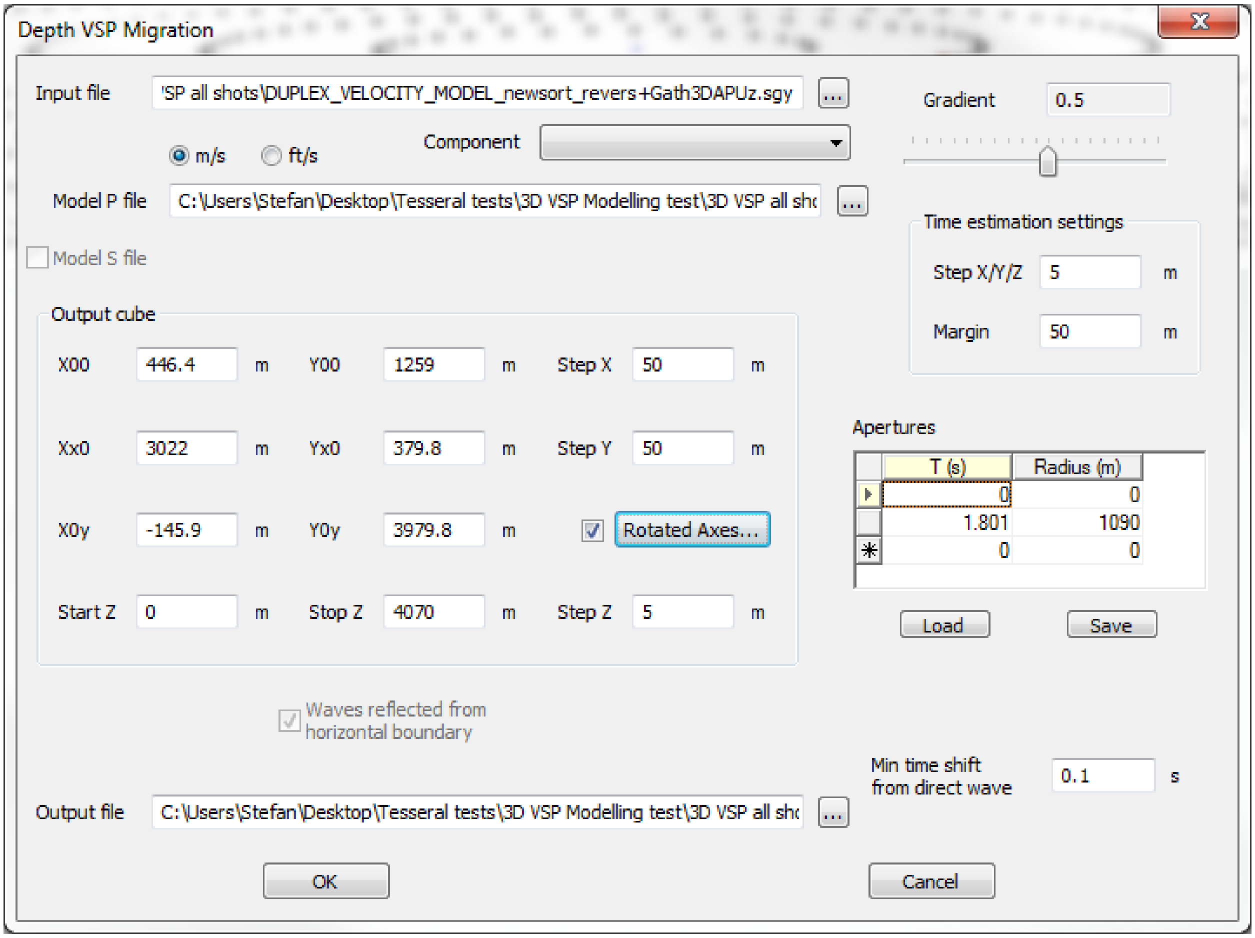
Unlike for DWM for PPP and converted waves, no base boundary is specified for this method. Instead, the `Depth interval` for scattered duplex waves, relative to the very bottom of the model is specified.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
A
1 Year-GathAP-Z-Negative offsets-DWMSW-Left-300.sgy
-100000 -80000 -60000 -40000 -20000 0 20000 40000 60000 80000 100000
X 2400 2450 2500 2550 2600 2650 2700 2750 2800 2850 2900 2950 3000 3050 3100 3150 3200 3250 3300 3350 3400 3450 3500 3550 3600 3650 3700 3750 3800 3850 3900 3950 4000 4050 4100 4150 4200 4250 4300 4350
Len 1400 1450 1500 1550 1600 1650 1700 1750 1800 1850 1900 1950 2000 2050 2100 2150 2200 2250 2300 2350 2400 2450 2500 2550 2600 2650 2700 2750 2800 2850 2900 2950 3000 3050 3100 3150 3200 3250 3300 3350
280
320
360
400
440
480
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 255 x 6 mm,
1 frames selected

10.5.6 Depth 3D VSP Migration

To run 3D depth VSP migration choose `Run > VSP procedures (Depth domain) > 3D Depth Kirchhoff VSP Migration (3D PSDM)` from the Menu.

Please note that only migration of P waves reflected from horizontal boundaries has been implemented for this method.



Depth VSP Migration

Input file: 'SP all shots\DUPLEX_VELOCITY_MODEL_newsort_revers+Gath3DAPUz.sgy

● m/s ○ ft/s

Component:

Model P file: C:\Users\Stefan\Desktop\Tesseral tests\3D VSP Modelling test\3D VSP all shc

☐ Model S file

Gradient: 0.5

Time estimation settings

Step X/Y/Z: 5 m

Margin: 50 m

Output cube

X00	446.4	m	Y00	1259	m	Step X	50	m
Xx0	3022	m	Yx0	379.8	m	Step Y	50	m
X0y	-145.9	m	Y0y	3979.8	m	☑ Rotated Axes...		
Start Z	0	m	Stop Z	4070	m	Step Z	5	m

Apertures

T (s)	Radius (m)
0	0
1.801	1090
0	0

☑ Waves reflected from horizontal boundary

Min time shift from direct wave: 0.1 s

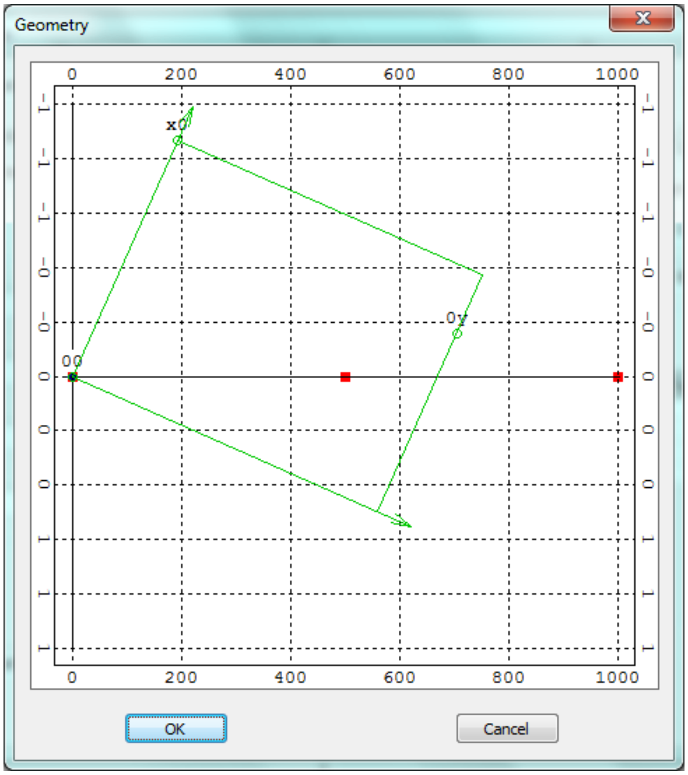
Output file: C:\Users\Stefan\Desktop\Tesseral tests\3D VSP Modelling test\3D VSP all shc

`Input file` – 3D seismogram file. If the file type is TGR (as opposed to SGY) it is necessary to specify the Component of the data file that is to be processed.

Next you must load the depth `Model P file` and specify the size of the output migrated cube.

The output (imaging) area is rectangular. And there are two ways to define this rectangle:

- In general case the output rectangle is defined manually by coordinates of 3 sequential corner points: `Xx0`, `Yx0`, `X00`, `Y00`, `X0y`, and `Y0y` in the `Rotated Axes` group. Approximate values may be used. The program adjusts the coordinates to form a true rectangle.



- If the output rectangle boundaries are parallel to coordinate axes it can be alternatively defined by the parameters: `StartX`, `StopX`, `StartY`, and `StopY`. The program supports output of vertical sections, so combinations like `StartX`=`StopX` and `StartY`=`StopY` are enabled.

`StartZ`, `StopZ` is depth interval of the output array. `StopZ` must be below (bigger) then boundary depths of the model file.

`StepX`, `StepY`, `StepZ` are the grid steps for the output array.

To specify the circular aperture explicitly enter directly the `T(s)` and `Radius(m)` in the `Apertures` group. If the migration aperture is not specified, the program uses default values.

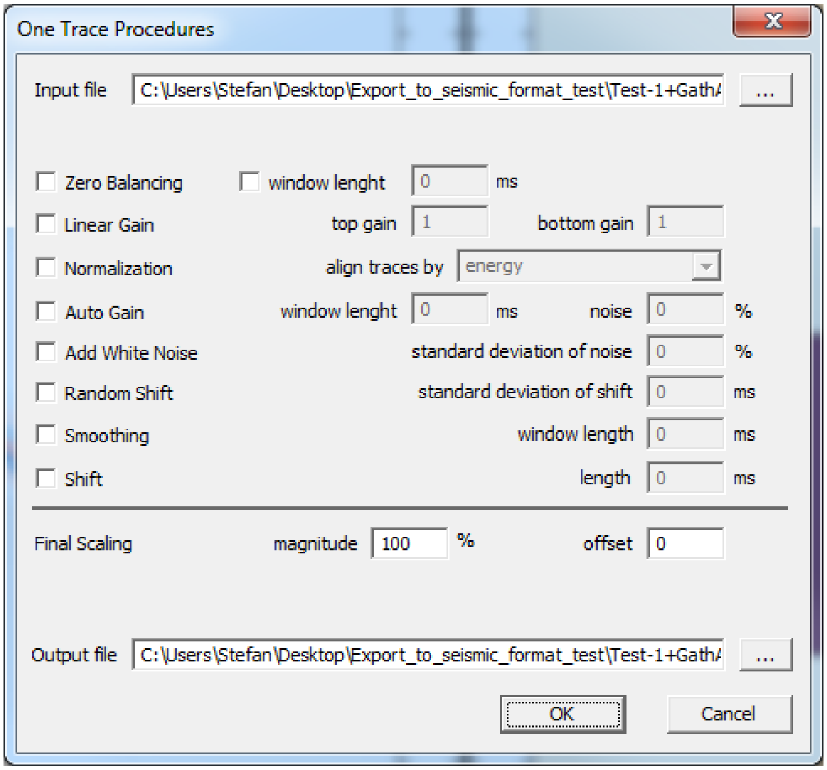
`Min. time shift from direct wave(s)` is used for muting VSP gathers by a particular time interval in order to eliminate the migration noise associated with the direct wave arrival.

The rest of the parameters in `Depth VSP Migration` window are exatly the same as for `2D Time/Depth Pre-Stack Kirchoff Migration` (Please see section 10.5).

10.6 Post-Processing

Procedures for post-processing of seismic data

10.6.1 Trace-wise Procedures



Input file C:\Users\Stefan\Desktop\Export_to_seismic_format_test\Test-1+Gath

☐ Zero Balancing ☐ window lenght 0 ms

☐ Linear Gain top gain 1 bottom gain 1

☐ Normalization align traces by energy

☐ Auto Gain window lenght 0 ms noise 0 %

☐ Add White Noise standard deviation of noise 0 %

☐ Random Shift standard deviation of shift 0 ms

☐ Smoothing window length 0 ms

☐ Shift length 0 ms

Final Scaling magnitude 100 % offset 0

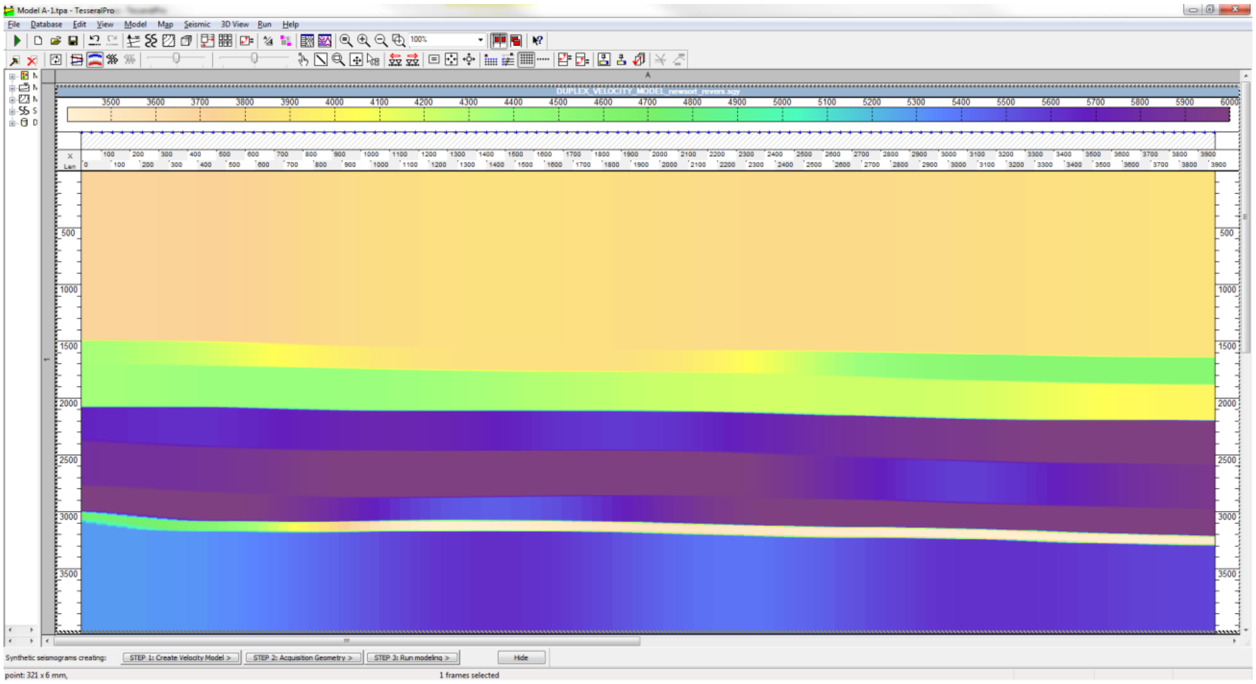
Output file C:\Users\Stefan\Desktop\Export_to_seismic_format_test\Test-1+Gath

Check a box to apply the function to all the traces.

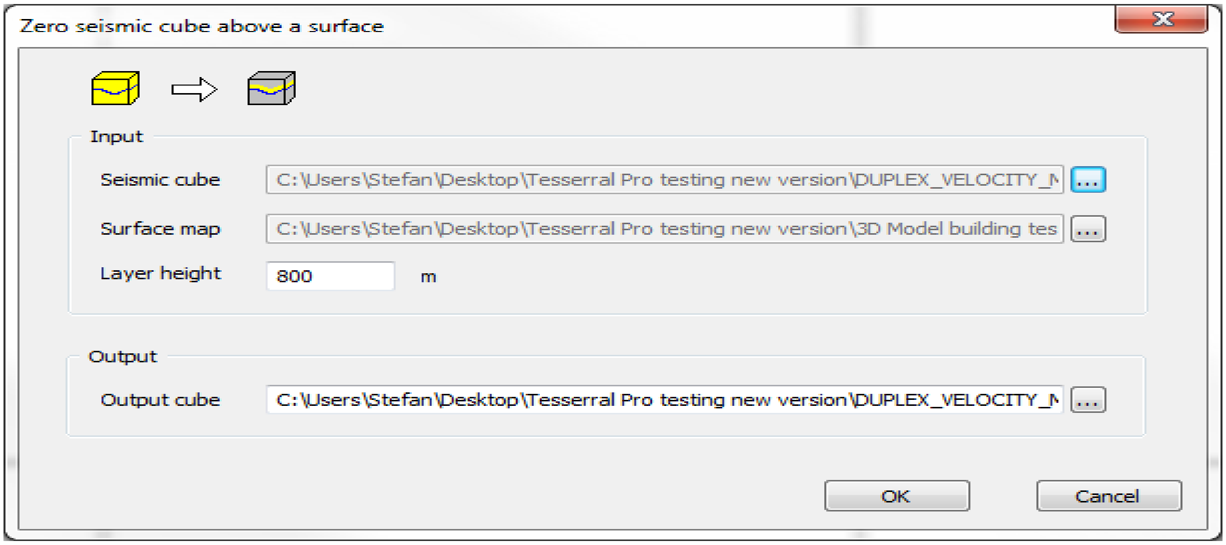
- `Zero Balancing` for balancing the traces to zero average value.
- `Linear Gain` is for increasing the amplitude of the top (`top gain`) or bottom (`bottom gain`) parts of the traces.
- `Normalization` is to normalize a trace using one of selected criteria.
- `Auto Gain` is to smooth the trace automatically. The parameters of such smoothing may be: `window length` is the time (or depth, metrical) interval for which the smoothing is carried out, `noise` is a threshold (noise threshold in percent of the maximal amplitude) and outside this threshold smoothing is suppressed.
- `Add White Noise` (in percent of the maximal amplitude) is to add white noise to the traces.
- `Random shift` is to add a random shift to the traces.
- `Smoothing` is to cut out the high frequency noises, if they are in the image.
- `Shift` is to shift the whole trace up or down along the time direction.
- `Final Scaling` (in percent of the maximal amplitude) is to change the absolute value of the amplitudes.

10.6.2 Zero seismic cube above a surface

With the help of this function the user can mute any given 3D seismic cube below the specified horizon. To implement this function first of all load the SGY cube File>Load seismic file…


Model A-1.tpa - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
1 frames selected

…followed by Run>Post processing>Zero Seismic Cube above a surface.


Zero seismic cube above a surface
OK
Cancel

Input

Seismic cube: C:\Users\Stefan\Desktop\Tesserral Pro testing new version\DUPLEX_VELOCITY_M

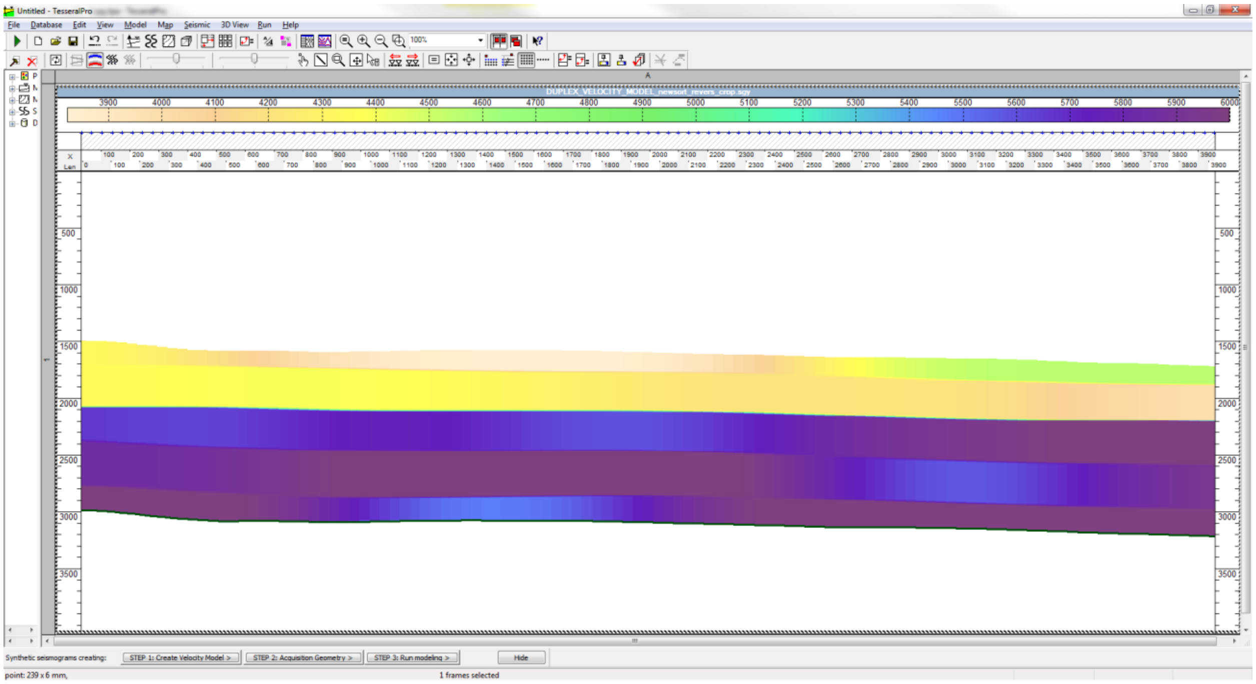
Surface map: C:\Users\Stefan\Desktop\Tesserral Pro testing new version\3D Model building tes

Layer height: 800 m

Output

Output cube: C:\Users\Stefan\Desktop\Tesserral Pro testing new version\DUPLEX_VELOCITY_M

Make sure the correct cube has been loaded in the Seismic cube dialogue, then load the Surface map (i.e. the horizon) and specify the Layer height, which is the distance above the horizon of the specified `Seismic cube` that should be preserved.


Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 239 x 6 mm,
1 frames selected

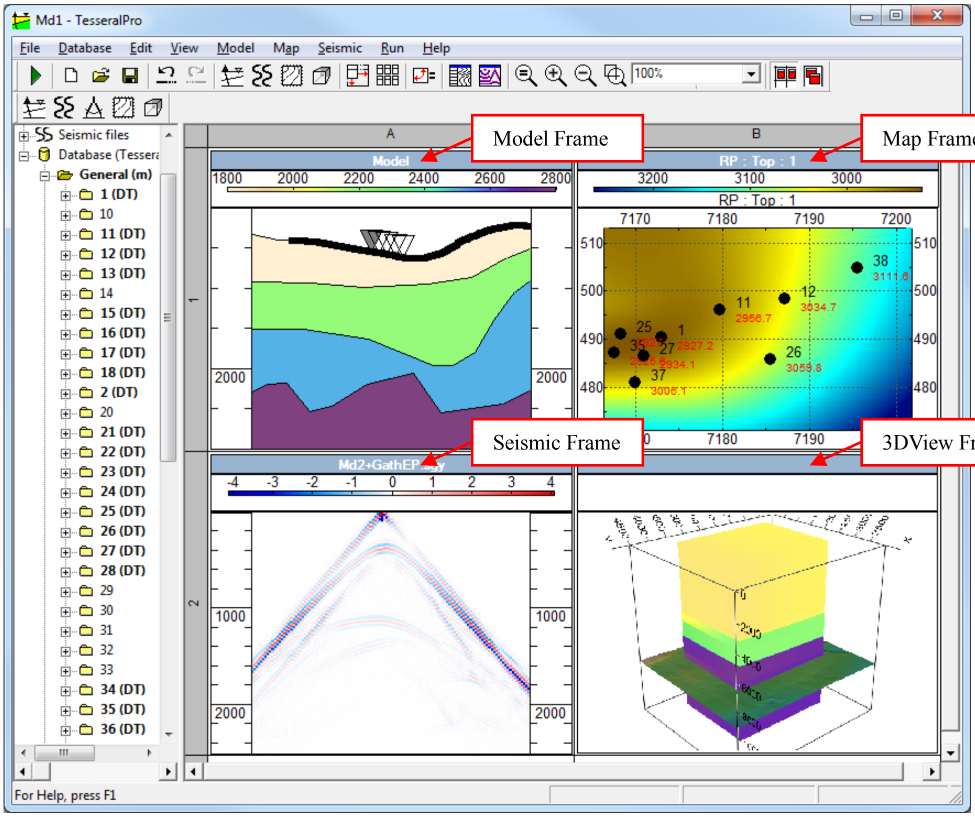
11 Frames

In this section, the general guidelines for manipulating different Frames are presented.

Tesseral Pro supports 4 types of Frames – model, surface, gather and 3D-view. The parameters for a Frames' display can be customized in the dialogue box and with the help of the options in the corresponding menu. Frames can be deleted, moved and duplicated. Operations with one or more Frames are supported as well. A Frame can be printed or exported to an exact vector (raster-type) picture (WYSIWYG technology). There are the two main modes to display Frames: `Document view` and `Tablet view`. More information can be found below.

11.1 Frame types

The Tesseral Pro program supports 4 types of Frames:

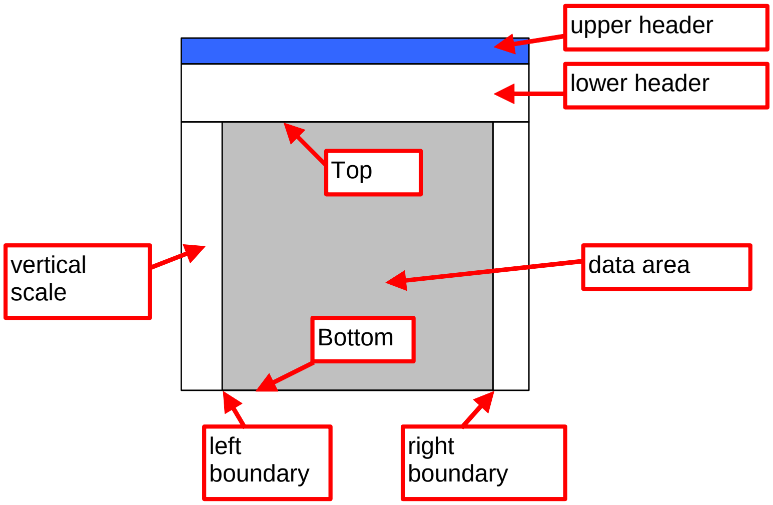

Md1 - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
Run
Help
100%
Seismic files
Database (Tessera
General (m)
1 (DT)
10
11 (DT)
12 (DT)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
24 (DT)
25 (DT)
26 (DT)
27 (DT)
28 (DT)
29
30
31
32
33
34 (DT)
35 (DT)
36 (DT)
A
B
1
2
Model
RP : Top : 1
Md2+GathEP
Model Frame
Map Frame
Seismic Frame
3DView Frame
For Help, press F1

- Model Frame (Model) is the Frame in depth. Model is always created in depth. The velocity model is formed by polygons based on the well logging and/or seismic data. The polygons are created by the user manually or automatically from the map of stratigraphic horizons (see Section *14.2.7*). Information related to velocity, density and anisotropy or fracturing can be entered in each polygon. The polygon parameters are set manually in the dialogue box or may be loaded from the well logging data for selected wells (thin layering). Information about shot and receiver points is also entered into the model. The built velocity models with shot-receiver layouts are used for calculation of the synthetic gathers. For more details about the Model Frame, please see Section *4*, *6*, and *12*.
- Map Frame (Map) is the Frame where the map of the wells location within the field and the map of the surface calculated by the well data or imported from external text files are displayed. The information needed for calculation of the surfaces, namely the coordinates of the layers and the wells intersections, should be loaded to the database in advance. Tesseral Pro has 9 methods for map generation, such as spline-approximation, Kriging and multiple regression. The cross-section model (Model Frame) for any section traced in the map is built automatically on the basis of the calculated (loaded) surfaces. More details about the Map Frame can be found in the Section *14*.
- Seismic Frame (Seismic) displays gathers in SEG-Y, SDS-PC, and TGR formats. 3D gathers display also is supported. Please see Section *13* for details about the Frame Seismic.
- 3D View Frame is for visualization of 3D images. Please see Section *15* for

details about the 3D View Frame.

To create a new frame, use the command `File > New Frame`. After that, in the dialogue box of the frame parameters, the default values may be changed.

Each type of frame has its own 2 headers (the upper and the lower one). In the upper header, any text is displayed (by default, the upper header looks like the header of a pane in Windows), and the lower header contains special information specific for each type of Frame.


upper header
lower header
Top
vertical scale
data area
Bottom
left boundary
right boundary

NOTE: Double click on the header of any frame to "expand" this frame to the whole window size (equivalent to the command `View > Frame Full Screen`). The repeated double click on a frame header arranges frames in form of "grid" inside the window (equivalent to the command `View > Arrange Frames`).

11.2 Frame Selection

Please use the left mouse button to select a Frame from the document field. The selected Frame will be shown inside a dotted rectangle. To cancel the selection, click outside the Frame boundaries using the left mouse button. The selection or de-selection of several Frames is implemented by the standard method for Windows. To select several Frames, please use the left mouse button together with the `Ctrl` or `Shift` key.

Also in the `Document View Mode`, you can select a group of Frames by pressing the left mouse button outside the Frames on the blank field of the document and then dragging it (while pressing the left mouse button) to create a rectangular area. All Frames that fall inside this area will be selected.

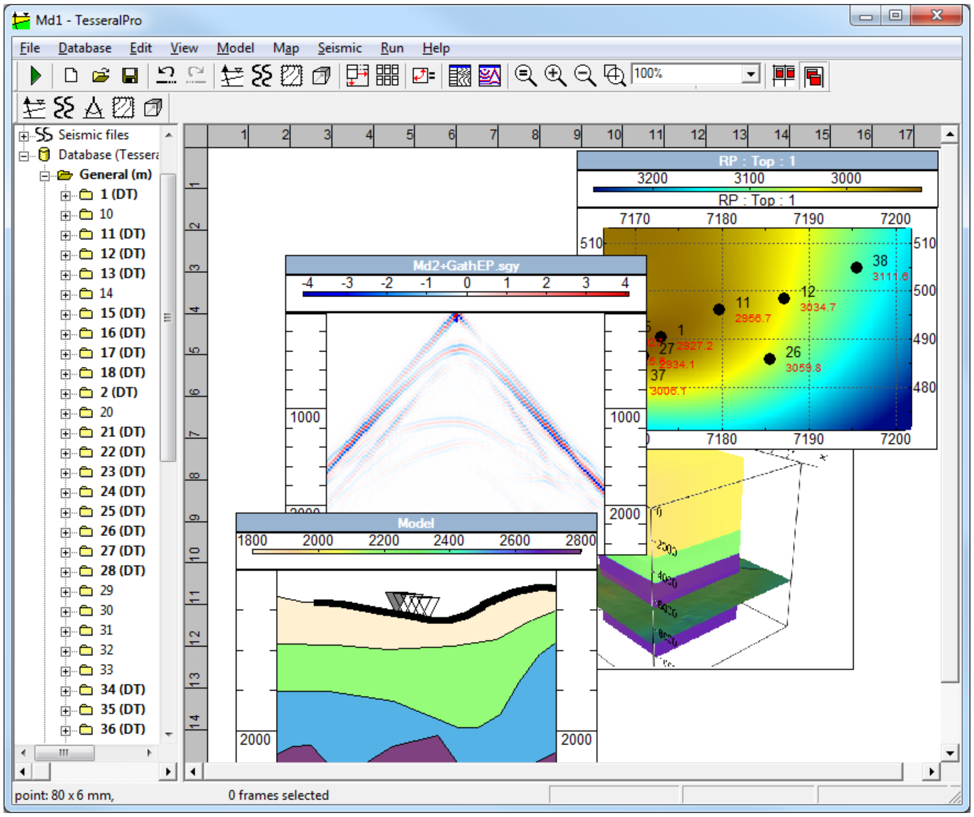
The last Frame selected is assumed to be the main Frame, and all the individual (non-group) commands will be applied to it. To change the selection of a Frame, click on it with the left mouse button while holding the `Shift` key. To select a Frame as the main one, please click on it with the left mouse button while holding the `Ctrl` key.

To select all Frames at once, please use the command `View > Select All Frames`, and to de-select all the Frames, use the command `View > Deselect All Frames`.

11.3 Frame layout

In order to move a Frame within the Tesseral Pro main window, please press and hold the left mouse button on the upper headline of the Frame and just drag it. There are two modes of Frame layout.

1. `View > Document View Mode` – Frames are freely distributed in the document.


Md1 - TesseralPro
File Database Edit View Model Map Seismic Run Help
Seismic files
Database (Tessera
General (m)
RP : Top : 1
Md2+GathEP.sgy
Model
point: 80 x 6 mm,
0 frames selected

In this mode, the Frames can overlap each other, therefore the commands `View > Bring Frame Forward` and `View > Bring Frame Backward` are used to set the right visualization order.

2. `View > Tablet View Mode` – Frames are only distributed in table cells. To change the size of any cell, please drag it with the mouse (while holding the left mouse button) from any Frame side, or change the size of the column (row) of the table in the internal axis of the Frame window.

If you drag a Frame into a cell used by another Frame, the old Frame will be moved to the nearest free cell.

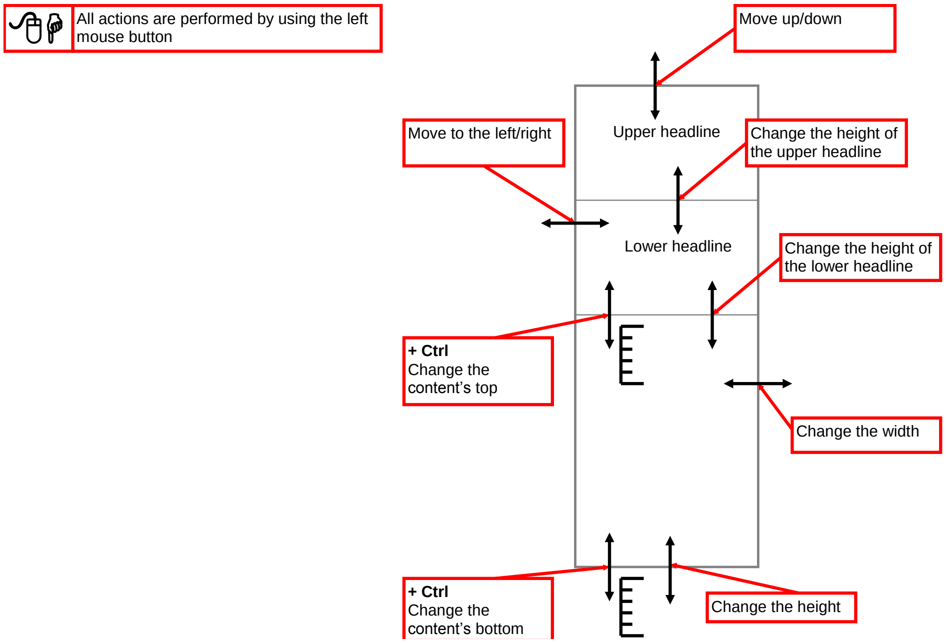
> **NOTE**: Please use the command `View > Arrange Frames` to sort the Frames automatically according to the sizes of their windows. For an easier way to work with selected Frame, please use the command `View > Frame Full Screen`.

11.4 Frame size

The width and the height of the Frames are adjusted in the dialogue box `Edit > Edit Frame Properties`. The height of the upper and the lower headers is defined in the dialogue boxes of the upper and the lower headers, respectively. For the Frames displayed in depth or time scale (Model and Seismic), the height and the width are calculated automatically from the top, bottom and scale information. The sizes of the Frames may be changed by the mouse, which can be done by dragging the Frame's borders while pressing the left mouse button. While several Frames are selected, the changes will be only applied to the main (last) selected Frame. The size of the remaining Frames will be the same. The height and the width of the upper and the lower headers will be changed by pressing and dragging the lower headline border.

> **NOTE**: It is possible to change the top and the bottom of any Frame with the scale by dragging the top or the bottom with the `Ctrl` key pressed.

The next picture shows the different ways to change the Frame parameters


All actions are performed by using the left mouse button
Move up/down
Move to the left/right
Upper headline
Change the height of the upper headline
Lower headline
Change the height of the lower headline
+ Ctrl
Change the content's top
Change the width
+ Ctrl
Change the content's bottom
Change the height

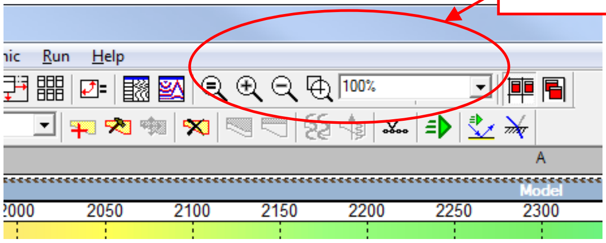
> **NOTE**: While changing the Frames' sizes in the Tablet View Mode, the sizes of all Frames in the same table row and column are also changed.

11.5 Undo/Redo

Working with Frames, you may undo any action (or sequence of actions) using `Edit > Undo`. To redo the action that you've undone, please use `Edit > Redo`. Commands `Undo` and `Redo` are not supported while working with files (menu `File`), database (menu `Database`) and calculating and editing seismic surfaces (`Map > Add New Horizon from Well Tops`, `Map > Manage/Delete Horizons`, `Map > Active Surface Processing`).

11.6 Scale of display

To scale the document (zoom in/out), please use the command `View > Zoom` or the scaling buttons in the main toolbar.


Buttons for zoom

ic Run Help
100%
A
Model
2000 2050 2100 2150 2200 2250 2300

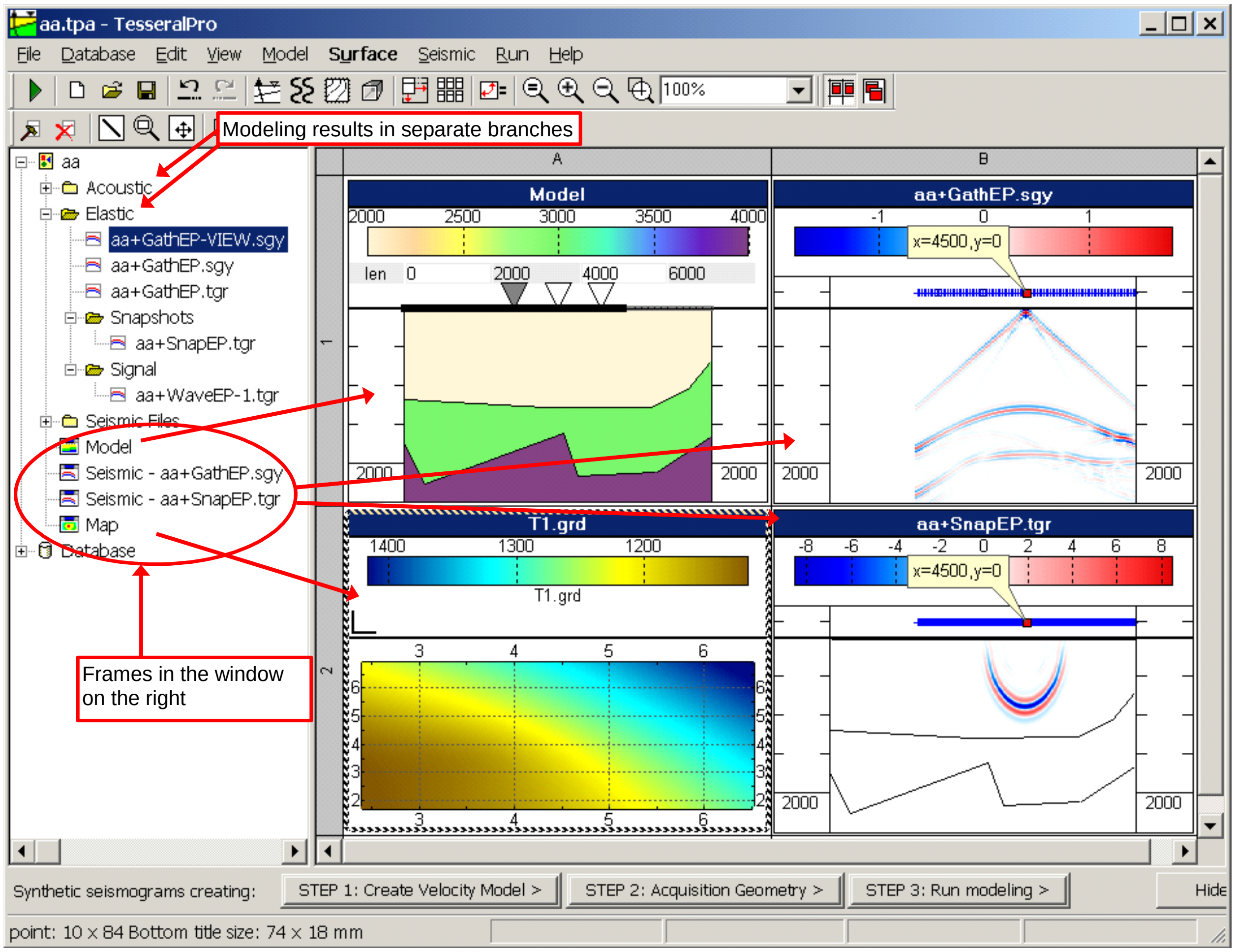
11.7 Print and export

Documents are created on the principle of WYSIWYG by using Frames. For more details, please see section *11.3*.

Please use the command `File > Print` to print a document.

Apart from printing, documents can be exported as a picture in any of the following formats (TIFF, EMF, WMF and BMP) by using the command `File > Save as Picture`.

11.8 Project tree and the database


aa.tpa - TesseralPro
File
Database
Edit
View
Model
Surface
Seismic
Run
Help
100%
aa
Acoustic
Elastic
aa+GathEP-VIEW.sgy
aa+GathEP.sgy
aa+GathEP.tgr
Snapshots
aa+SnapEP.tgr
Signal
aa+WaveEP-1.tgr
Seismic Files
Model
Seismic - aa+GathEP.sgy
Seismic - aa+SnapEP.tgr
Map
Database
A
B
Model
aa+GathEP.sgy
T1.grd
aa+SnapEP.tgr
x=4500,y=0
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 10 x 84 Bottom title size: 74 x 18 mm

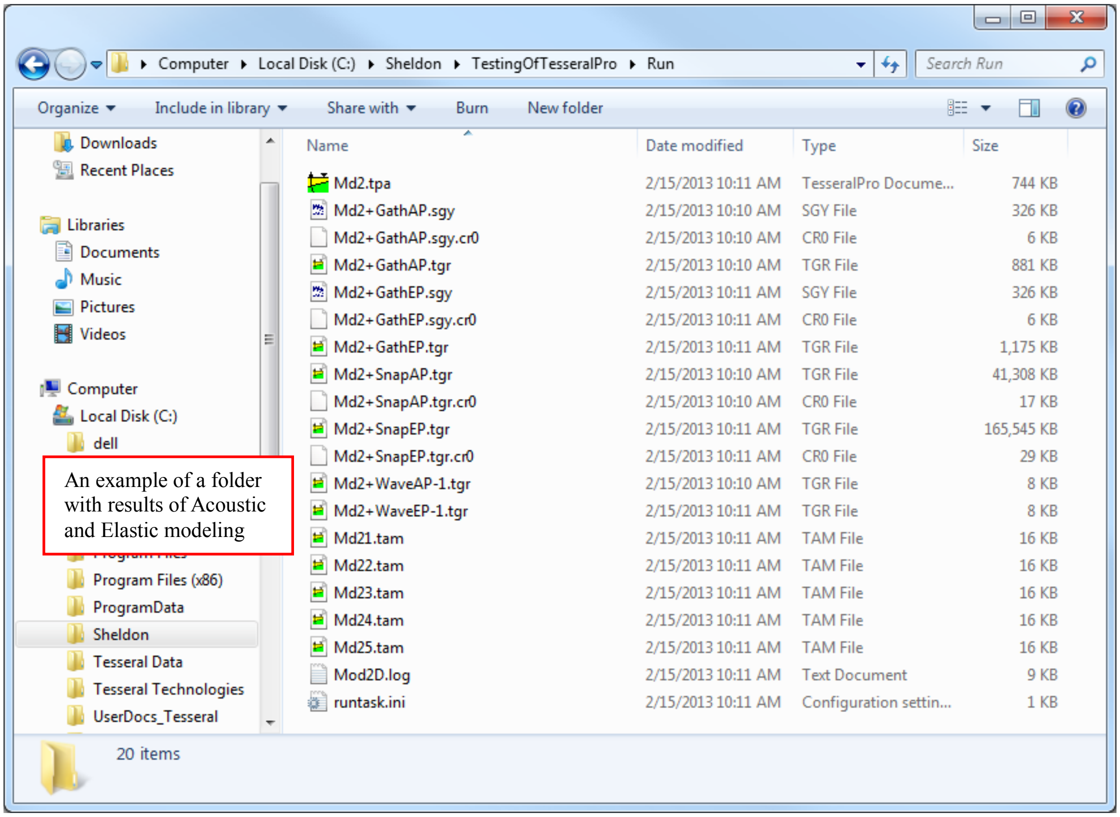
Modeling results in separate branches

Frames in the window on the right

After the new project is saved (command `File > Save Project)`, or after loading of an old project, in the left window of Tesseral Pro, the tree of the opened project is shown. This tree helps to systemize all loaded and created files.

The point is that, during the modeling of synthetic gathers, several files are created and they are all located within the same folder (please see details in the Section *7.4*). Additionally, after launching several jobs for the same model using different modeling techniques, more sets of output files are created. All these files are located in the same folder, and it may be complicated to find the needed one. The project tree will simplify this task. The branches in the tree have the same names as the corresponding modeling method (`Acoustic`, `Elastic`, etc.). The remaining seismic files, which are created, for instance, by procedures of gather processing, are located in the branch `Seismic files` of the project tree. A double mouse click on a file in the project tree will create a Seismic Frame for this file in the right window of Tesseral Pro.

The branch «Database» connects to the Tesseral Pro database (please see details in the Section *17*).


Computer ▸ Local Disk (C:) ▸ Sheldon ▸ TestingOfTesseralPro ▸ Run
Search Run
Organize
Include in library
Share with
Burn
New folder
Downloads
Recent Places
Libraries
Documents
Music
Pictures
Videos
Computer
Local Disk (C:)
dell
Program Files (x86)
ProgramData
Sheldon
Tesseral Data
Tesseral Technologies
UserDocs_Tesseral
20 items

Name	Date modified	Type	Size
Md2.tpa	2/15/2013 10:11 AM	TesseralPro Docume...	744 KB
Md2+GathAP.sgy	2/15/2013 10:10 AM	SGY File	326 KB
Md2+GathAP.sgy.cr0	2/15/2013 10:10 AM	CR0 File	6 KB
Md2+GathAP.tgr	2/15/2013 10:10 AM	TGR File	881 KB
Md2+GathEP.sgy	2/15/2013 10:11 AM	SGY File	326 KB
Md2+GathEP.sgy.cr0	2/15/2013 10:11 AM	CR0 File	6 KB
Md2+GathEP.tgr	2/15/2013 10:11 AM	TGR File	1,175 KB
Md2+SnapAP.tgr	2/15/2013 10:10 AM	TGR File	41,308 KB
Md2+SnapAP.tgr.cr0	2/15/2013 10:10 AM	CR0 File	17 KB
Md2+SnapEP.tgr	2/15/2013 10:11 AM	TGR File	165,545 KB
Md2+SnapEP.tgr.cr0	2/15/2013 10:11 AM	CR0 File	29 KB
Md2+WaveAP-1.tgr	2/15/2013 10:10 AM	TGR File	8 KB
Md2+WaveEP-1.tgr	2/15/2013 10:11 AM	TGR File	8 KB
Md21.tam	2/15/2013 10:11 AM	TAM File	16 KB
Md22.tam	2/15/2013 10:11 AM	TAM File	16 KB
Md23.tam	2/15/2013 10:11 AM	TAM File	16 KB
Md24.tam	2/15/2013 10:11 AM	TAM File	16 KB
Md25.tam	2/15/2013 10:11 AM	TAM File	16 KB
Mod2D.log	2/15/2013 10:11 AM	Text Document	9 KB
runtask.ini	2/15/2013 10:11 AM	Configuration settin...	1 KB

An example of a folder with results of Acoustic and Elastic modeling

Some branches of the project tree are the frame branches (Model, Surface, and Seismic). Double click these items to maximize the corresponding size in the window on the right.

12 Model Frame

The Model Frame is used for creating depth velocity models using polygons, well data, underlying seismic images (2D or 3D models). After that, the velocity depth model is used for calculating synthetic gathers.

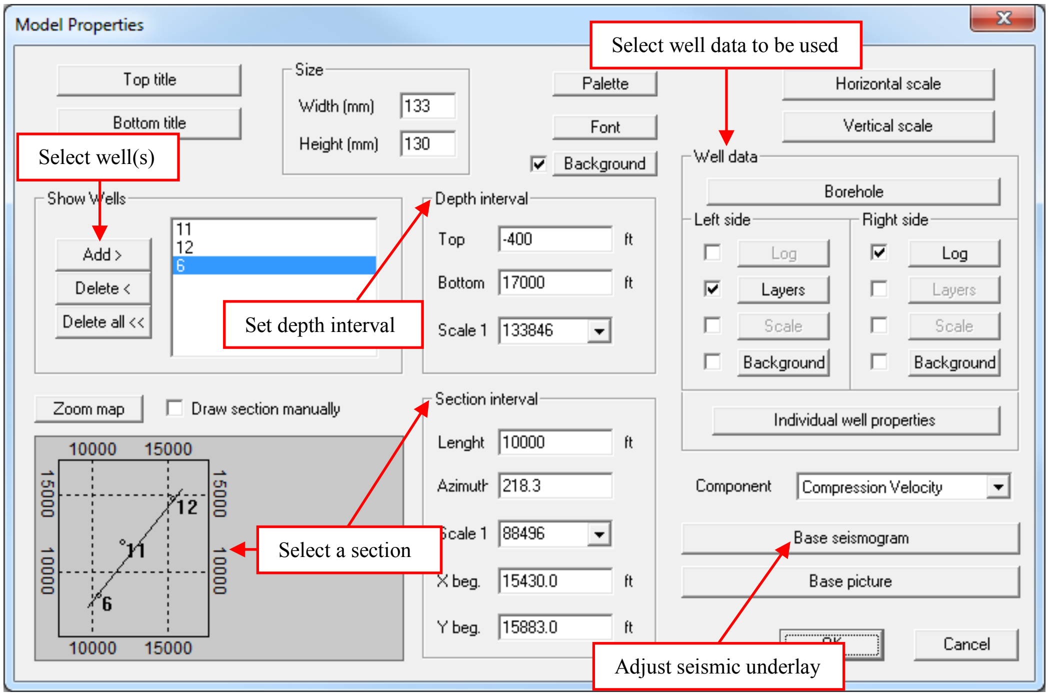
Please see:

- Section ***4*** for details about model creation
- Section ***5.9*** and ***17.5*** for using well data
- Section ***4.11*** about filling of a model with polygons, Section ***6*** about creation of the acquisition geometry
- Section ***7*** about launching job of modeling a synthetic gather
- Section ***13*** about displaying computed gathers, seismic models and field gathers

Please see below for some additional features about using the Model Frame.

12.1 Properties of the Model Frame

To invoke the dialogue box with properties for an existing Model Frame, please select the command `Model > Model Frame Properties`.



Select well data to be used

Select well(s)

Set depth interval

Select a section

Adjust seismic underlay

Size: Width (mm) 133; Height (mm) 130

☑ Background

Show Wells: 11, 12, 6

Depth interval: Top -400 ft; Bottom 17000 ft; Scale 1 133846

☐ Draw section manually

Section interval: Lenght 10000 ft; Azimuth 218.3; Scale 1 88496; X beg. 15430.0 ft; Y beg. 15883.0 ft

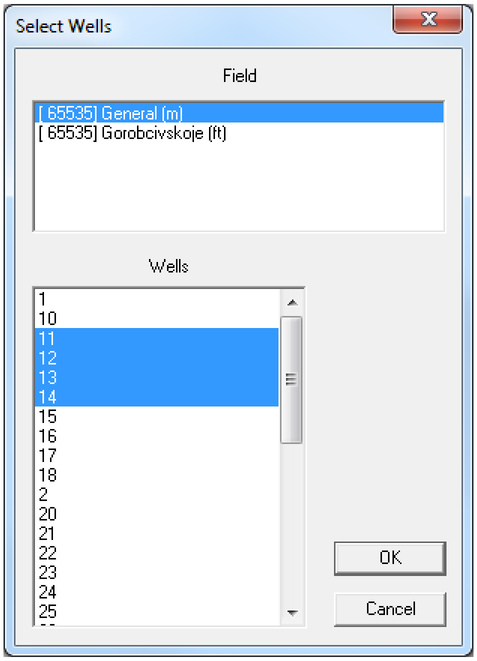
Well data: Left side: ☐ Log, ☑ Layers, ☐ Scale, ☐ Background; Right side: ☑ Log, ☐ Layers, ☐ Scale, ☐ Background

Component: Compression Velocity

Model Properties
Top title
Bottom title
Palette
Font
Horizontal scale
Vertical scale
Borehole
Add >
Delete <
Delete all <<
Zoom map
10000
15000
12
11
6
Individual well properties
Base seismogram
Base picture
OK
Cancel

All the parameters input via the model building Wizard, may be changed manually in the dialogue box `Model Properties`.

To select wells for the model – Please click the button `Add >`.

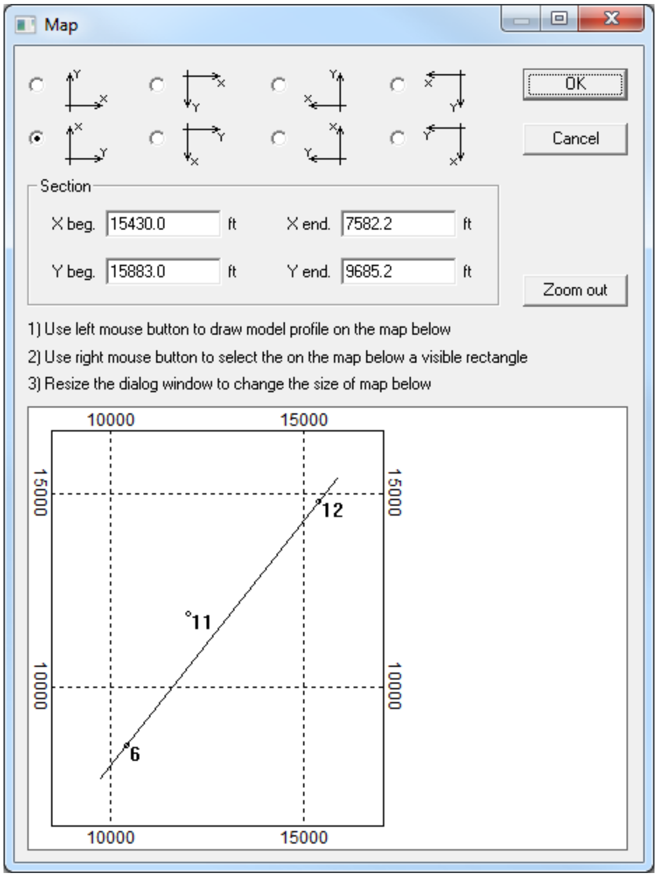


Field:
- [65535] General (m)
- [65535] Gorobcivskoje (ft)

Wells: 1, 10, 11, 12, 13, 14, 15, 16, 17, 18, 2, 20, 21, 22, 23, 24, 25

Select Wells
OK
Cancel

To select a section line – along which the model section will be created. After checking the option `Draw section manually`, in the lower left corner of the `Model Properties` dialogue box, you can draw the section line by using the mouse by pressing-dragging-releasing. To define the section line more precisely, you can: A) Select the origin coordinates, the azimuth and the length of the line in the Section interval group; or B) Click the Zoom map button to load the map for visual input.

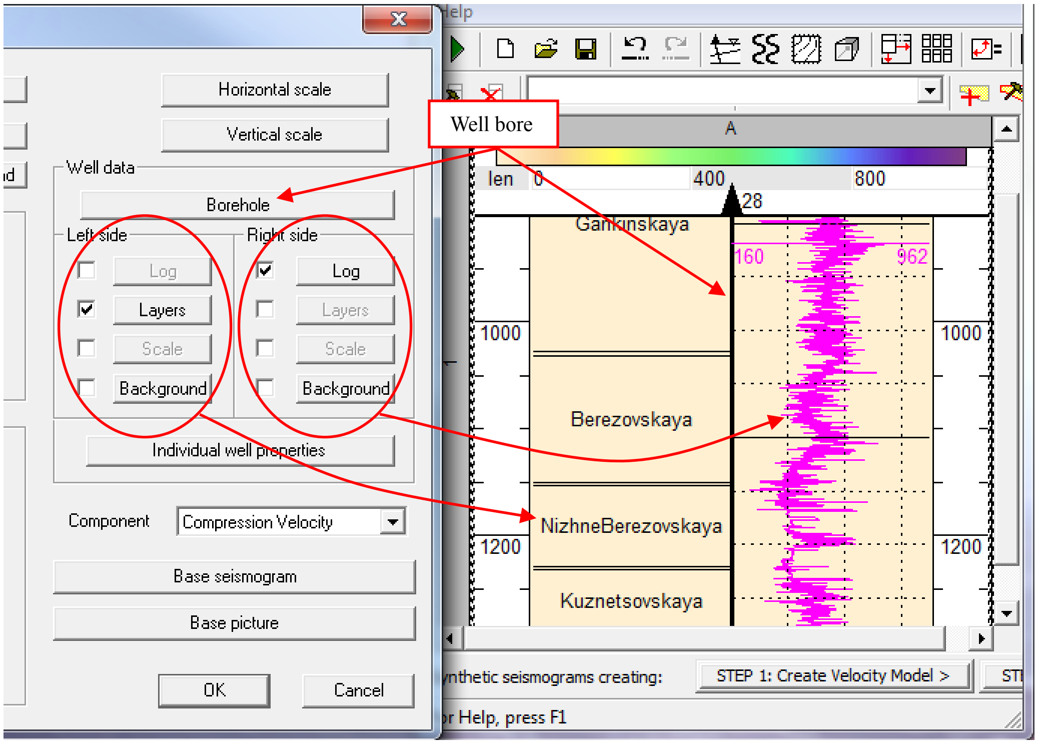


X beg. 15430.0 ft
X end. 7582.2 ft
Y beg. 15883.0 ft
Y end. 9685.2 ft

1) Use left mouse button to draw model profile on the map below
2) Use right mouse button to select the on the map below a visible rectangle
3) Resize the dialog window to change the size of map below

To set depth interval – In the Depth interval group, please specify the top and the bottom of the model.

To select the data to be displayed for the well – In the Well data group,


Horizontal scale
Vertical scale
Well data
Borehole
Left side
Right side
☐ Log
☑ Layers
☐ Scale
☐ Background
☑ Log
☐ Layers
☐ Scale
☐ Background
Individual well properties
Base seismogram
Base picture
OK
Cancel
Well bore
A
len
0
400
800
28
Garkinskaya
160
962
1000
Berezovskaya
NizhneBerezovskaya
1200
Kuznetsovskaya
STEP 1: Create Velocity Model >
ynthetic seismograms creating:
or Help, press F1

Component: Compression Velocity

<u>`Left side`</u> – The data to be displayed on the left side of the well bores

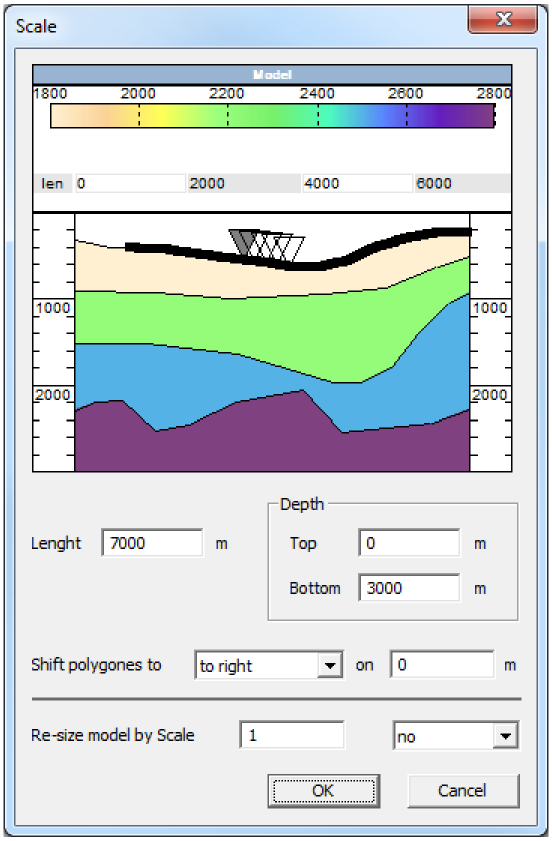
<u>`Right side`</u> – The data to be displayed on the right side of the well bores

Please select the type of well data you want to display.

<u>`Log`</u> – The well log data. From the dialogue box of the well log parameters, please select the logs you want to display. For more details, see the Section *5.10*.

12.2 Model re-size

The command Model > Scale is used.


Scale
Model
1800
2000
2200
2400
2600
2800
len
0
2000
4000
6000
1000
2000
1000
2000
OK
Cancel

Lenght 7000 m

Depth
Top 0 m
Bottom 3000 m

Shift polygones to to right on 0 m

Re-size model by Scale 1 no

Using this command, you may change the size of the model by stretching or compressing all polygons and location of sources and receivers consistently, which is done by specifying the parameter Re-size model by Scale.

NOTE: If you like to change the measurement units for the whole project (ft to m or m to ft), it is recommended to use the command File > Project Properties (please see details in the Section *16*).

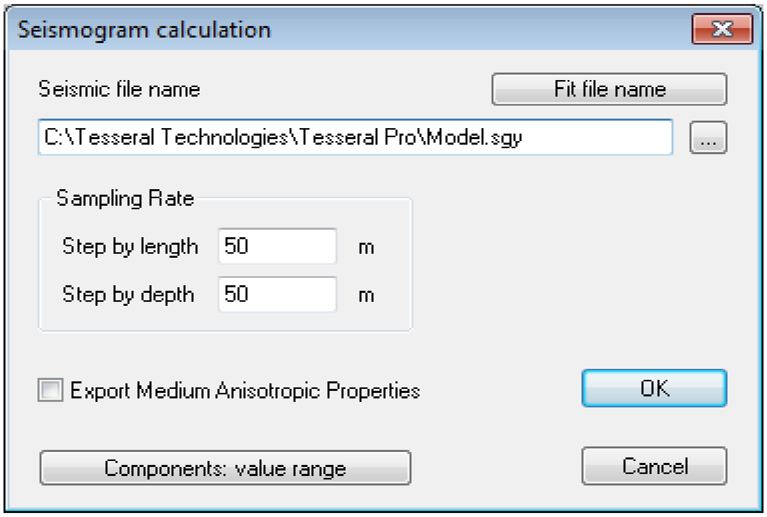
If the parameter Length, Top or Bottom is changed, the polygons of the model will not be stretched nor shifted.

12.3 Model export

It is possible to export a model to any of the 3 seismic formats (TGR, SDS-PC or SEG-Y), and to a TAM format used by Tesseral 2D.

12.3.1 Model export to a seismic format

Please use the command `Model > Export to Seismic Format (SEG-Y, TGR)`.



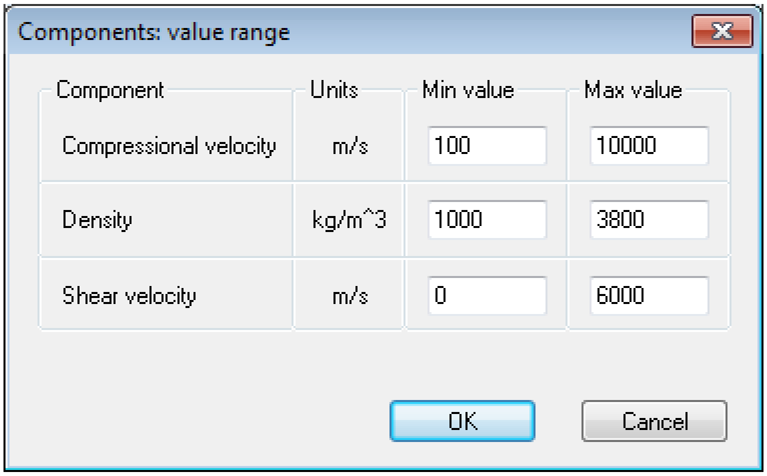
Seismic file name: C:\Tesseral Technologies\Tesseral Pro\Model.sgy

Sampling Rate

Step by length 50 m

Step by depth 50 m

☐ Export Medium Anisotropic Properties



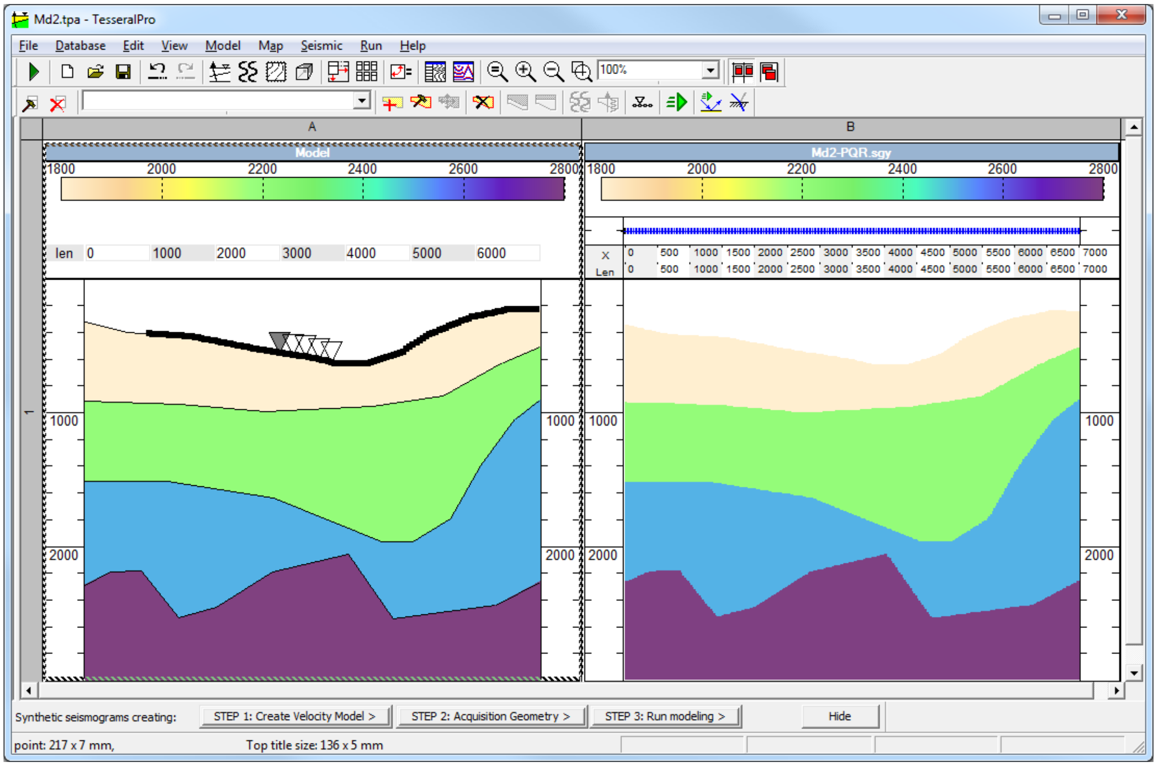
Component	Units	Min value	Max value
Compressional velocity	m/s	100	10000
Density	kg/m^3	1000	3800
Shear velocity	m/s	0	6000

In this dialogue box, please specify the cell size, the name of the output file. The minimum and maximum values of each component in the `Components: value range window` are to limit the possible spikes after interpolating the well log data.

> **NOTE:** If the TGR file contains multiple components or if you export a model in SDS-PC or SEG-Y formats, then 3 files will be generated (one file for each component). File with the selected name will contain the data of `Compressional velocity` (**<file name>–PQR.sgy**), `Density` (**<file name>–PQR_Q.SGY**) and `Shear velocity` (**<file name>–PQR_R.SGY**).

After creating these files, a Seismic Frame should appear in the Tesseral Pro window to display the gathers created from the model.

Please see results

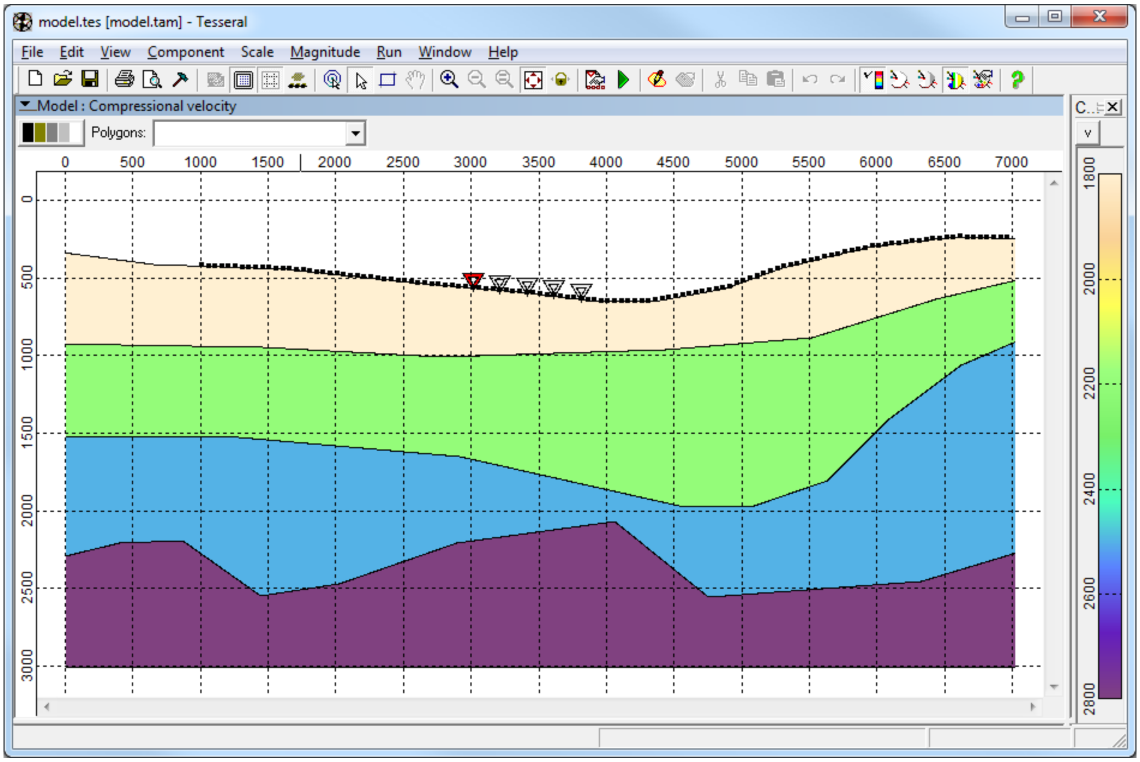

Md2.tpa - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
Run
Help
100%
A
B
Model
Md2-PQR.sgy
1800
2000
2200
2400
2600
2800
len
0
1000
2000
3000
4000
5000
6000
X
Len
500
1500
2500
3500
4500
5500
6500
7000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

point: 217 x 7 mm, Top title size: 136 x 5 mm

NOTE: The acquisition parameters data are not exported when model is exported to any seismic format.

12.3.2 Model export to Tesseral 2D (TAM format)

Please use the command `Model > Export to Tesseral 2D Format (TAM)`.


model.tes [model.tam] - Tesseral
File Edit View Component Scale Magnitude Run Window Help
Model : Compressional velocity
Polygons:
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000
0 500 1000 1500 2000 2500 3000
1800 2000 2200 2400 2600 2800

While the model is being exported to TAM file, the thin layering data is not exported, but the acquisition geometry data is exported.

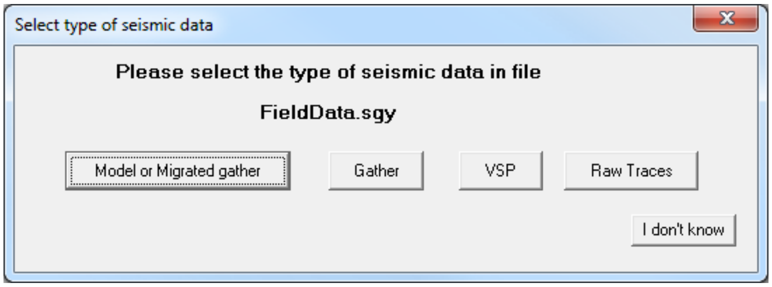
13 Frame Seismic

This is the frame to display files in SEG-Y, SDS-PC or TGR formats. The frame is to support displaying 2D/3D field and synthetic gathers, models, migrated slices/cubes, VSP gathers, multi-component files, snapshots of wavefield propagation, etc.

13.1 Load seismic files

The seismic files are loaded by using the command `Seismic > Load Seismic File (New Frame)` ( ). If several files are loaded at once, then they will be displayed in the joint coordinate space.

If a seismic file is opened for the first time, it is proposed to select its type to apply the appropriate display mode, as shown below.


Select type of seismic data
Model or Migrated gather
Gather
VSP
Raw Traces
I don't know

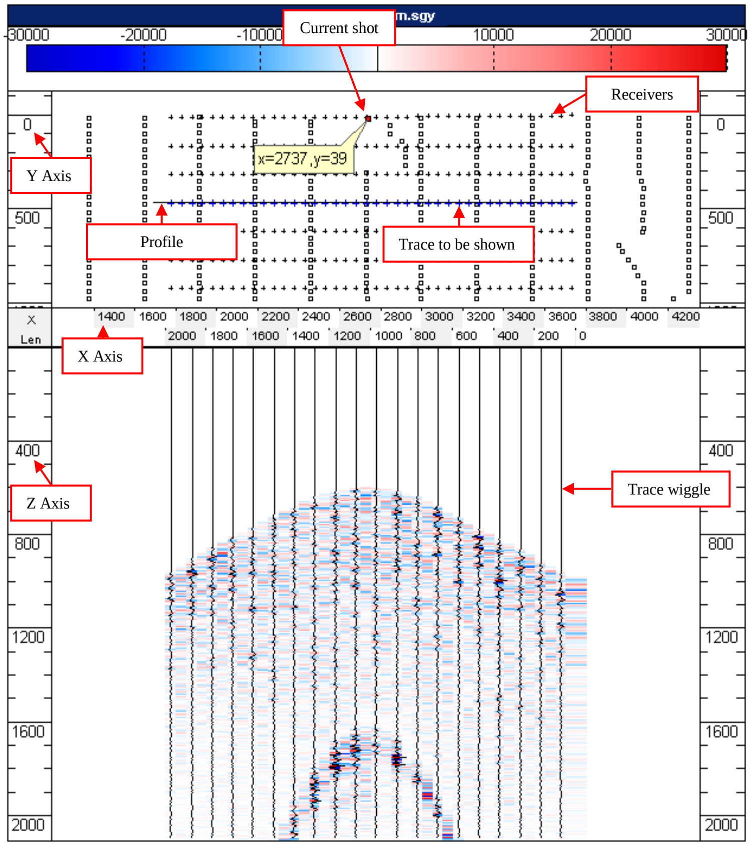
Please select the type of seismic data in file

FieldData.sgy

Your selection will determine the displaying mode (please see Section *13.2*), which can be changed at any time by using the `View Mode` command on the `Seismic` menu or the button from the toolbar.

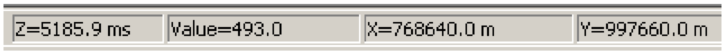
After that, your seismic file will be read. If a file is opened for the first time, it may take a long time to create the index files of the trace coordinates, which will be used later for optimizing the display.

The Frame Seismic represents a rectangular graphic object which includes the images of the source/receiver spread (above) and the traces (below). On the edge of the frame, the scale for the X/Y/Z axis is displayed. On the top, the color palette of the trace values is shown:


m.sgy
-30000
-20000
-10000
10000
20000
30000
Current shot
Receivers
x=2737 ,y=39
Y Axis
Profile
Trace to be shown
0
500
X
Len
1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800 4000 4200
2000 1800 1600 1400 1200 1000 800 600 400 200 0
X Axis
Z Axis
Trace wiggle
400
800
1200
1600
2000

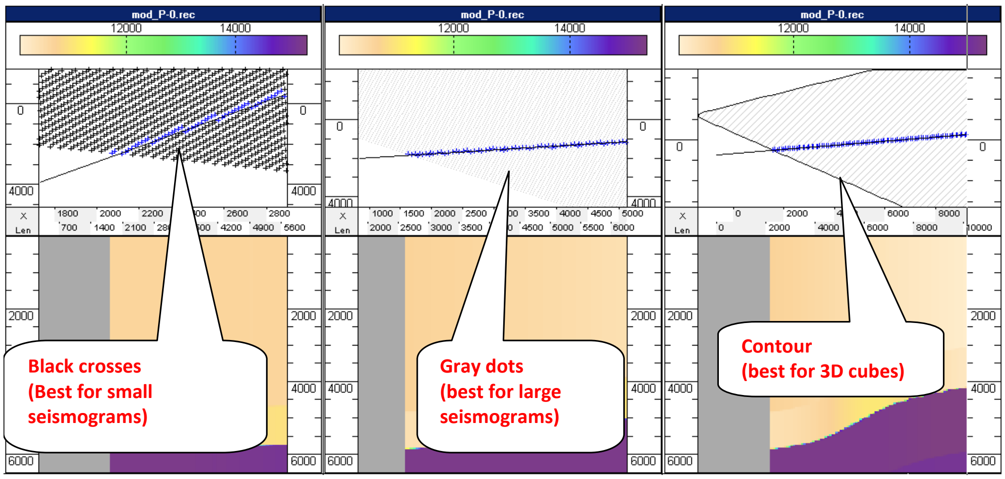
In the source/receiver spread, the positions of sources (small squares) and the coordinates of traces (small crosses) are shown. The current source is marked in red and its coordinates are shown in a balloon. The trace view may include the wiggle of the trace and the images corresponding to the palette. The coordinates of the sources and receivers in the spread may be displayed differently. These settings can be changed in the Frame Properties dialog, which is called by the button () (please see the Section *13.8*).

While moving the mouse cursor in the sections area (the vertical or the horizontal slice), the mouse cursor's coordinates and the corresponding trace value are displayed in the status bar.



Z=5185.9 ms | Value=493.0 | X=768640.0 m | Y=997660.0 m

13.1.1 Plan view

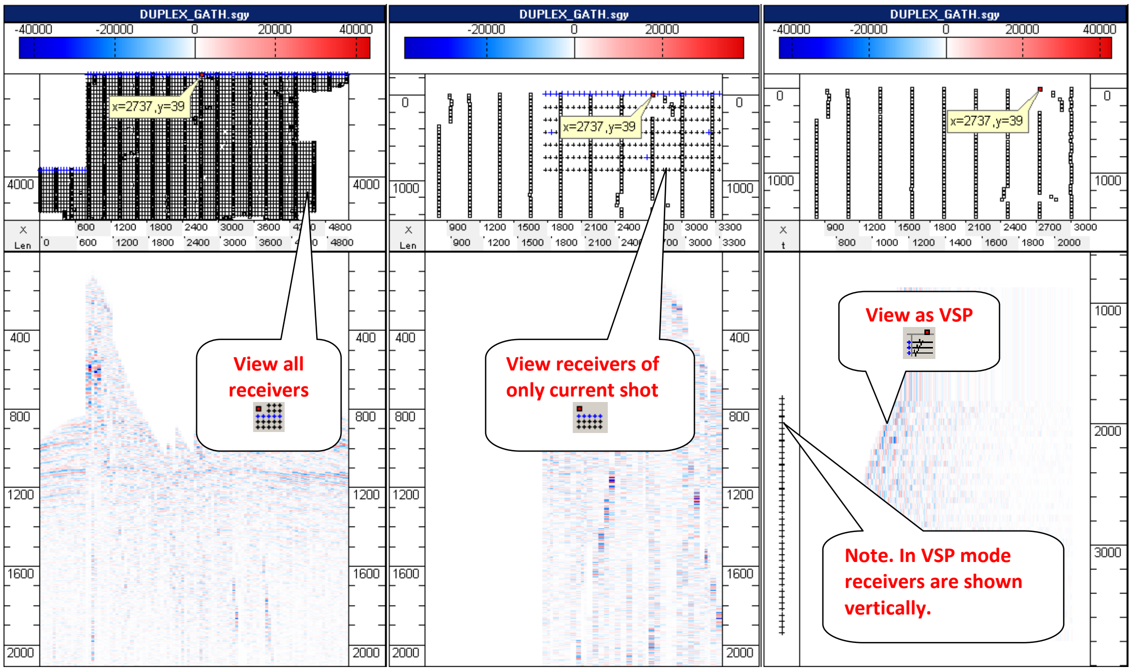


mod_P-0.rec
12000
14000
Black crosses
(Best for small
seismograms)
Gray dots
(best for large
seismograms)
Contour
(best for 3D cubes)

The positions of the sources are always displayed as small squares, but the way of displaying the receiver's position depends on the display mode. For the seismic data with a small number of traces, the receiver's position is shown as crosses. For large gathers, the receiver's position is shown as grey dots. For very big gathers or cubes, the receiver's position is shown as contours.

13.2 Trace display

In Tesseral Pro, there are several modes to display traces, and each of the modes is suitable for a specific task and type of seismic data. To preview gathers, 3 modes are commonly used, as illustrated in the figure below (from left to right: "`Show All Receivers`", "`Show Current Shotgather`" and "`Show as VSP`").


DUPLEX_GATH.sgy
x=2737 ,y=39
View all receivers
View receivers of only current shot
View as VSP
Note. In VSP mode receivers are shown vertically.

(1) (2) (3)

1. In the `Show All Receivers` mode, the spread of all the sources and receivers is shown in the top view. This mode is used if you want to have an overview of the whole field under study, and also get the sections of trace profiles belonging to several different sources.
2. The `Show Current Shotgather` mode is for displaying shot gathers. Only the traces of the current source are shown. It can also be used to show the traces of the chosen receivers along any profile.
3. The `VSP` mode is used for visualization of the VSP traces. The sources are located vertically (usually inside a well) and the traces are shown from left to right.

13.3 Operations with Seismic Frame

While working with the Seismic Frame, 4 Edit Modes can be used: Select Source Mode (), Draw Profile Mode (), Zoom Mode () and Move Mode ().

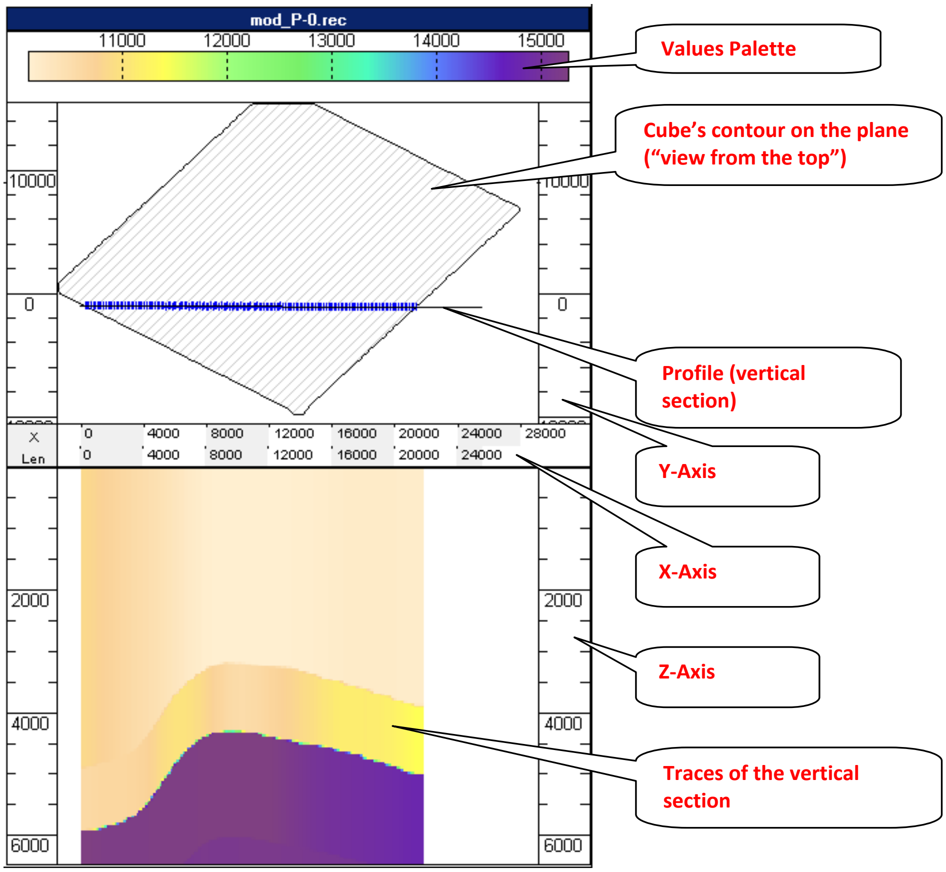
The Select Source Mode allows selecting an active source and this source will be marked in red on the acquisition surface and its coordinates will be shown in a balloon. The `Draw Profile Mode` allows selecting the vertical section by drawing a line on the top view. In this case, the receivers will fall into the section if their distance to the profile is less than the given one (this distance is computed automatically during the opening of the seismic file, but it may be changed in the settings). In the `Zoom Mode` and the `Move Mode`, it is possible to zoom in and drag both the acquisition surface and the vertical section.

Let's describe each of the modes for displaying seismic files.

- “`Select Source Mode`” ( ) enables to show the current source and its corresponding traces.
- “`Draw Profile Mode`” () enables to draw a profile manually in the top view. Please see Section *13.5* for more details. Additionally, in this mode, a horizontal section can be shown.
- “`Zoom Mode`” () enables to enlarge the image for the given area.
- “`Zoom In`” () enables to enlarge image.
- “`Zoom Out`” () enables to reduce image.
- “`Zoom 100%`” () enables to zoom out the image fully.
- “`Zoom To`” opens a dialogue box to set the zoom parameters.
- “`Rescale to Make X Scale = Y Scale`” () changes the Frame sizes so that the proportions of the geographic coordinates in the top view correspond to the visual ones.
- “`Rescale to Make X Scale = Z Scale`” () changes the Frame sizes so that the proportions of the geographic coordinates of the traces correspond to the visual ones.
- “`Normalize Palette by Visible Data`” () fixes the maximum and the minimum in the color palette to match the minimal and maximal values in the data currently visible in the Frame.
- “`Normalize Palette by All Data`” () fixes the maximum and the minimum in the color palette to match the minimal and maximal values in the seismic files currently loaded in the Frame.
- “`Show Component`” enables to select the components to be displayed (for the TGR format).
- “`Next/Previous Shotpoint`” (/) enables to set next/previous source as the current source.
- “`Export Traces Coordinates`” enables to export the trace coordinates to a text file.
- “`Import Traces Coordinates`” enables to import the trace coordinates from a text file.
- “`Refresh`” () re-load the data in the Frame (re-read all the data from the seismic files).
- “`Apply Settings to all Seismic Frames`” () enables to apply the settings of the current Frame to other Frames.

13.4 Preview of 3D seismic models or 3D migration results

Users can preview the 3D raster cubes in the Seismic Frame using the mode "`Show as Model`" (▦ and forming horizontal and vertical slices along any user-defined profile. As such cubes are in the format of seismic data, the cube's content is in form of traces. In this case, to describe the X and Y coordinates, the coordinates of the trace's receiver are used, and the Z coordinate is determined from the trace itself. In the general case, the coordinates of the source are ignored, but for compatibility with the seismic data preview tools, it is more suitable either to suppose that the source coordinates are equal to the receiver coordinates, or to create one source for the receivers having Y=const (this is implemented in Tesseral Pro), for which the X coordinate will be equal to the minimal X coordinate of receivers.

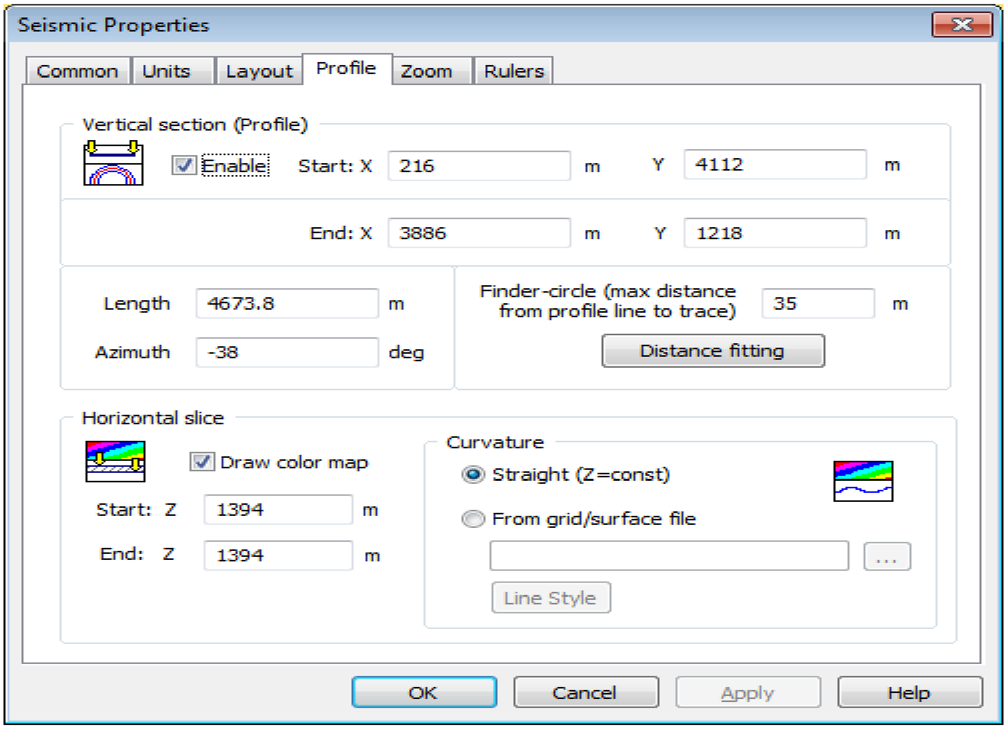

mod_P-0.rec
11000
12000
13000
14000
15000
10000
0
X
Len
0
4000
8000
12000
16000
20000
24000
28000
2000
4000
6000
Values Palette
Cube's contour on the plane ("view from the top")
Profile (vertical section)
Y-Axis
X-Axis
Z-Axis
Traces of the vertical section

13.5 Profiles

The easiest way to create a profile is to switch to "`Draw Profile Mode`" (⧅), then draw the line manually on the top view, only those traces whose distance to the profile is within the pre-defined value specified in the object's properties will be included into the section. If the pre-defined distance is too large, the traces outside the profile will be displayed. If the pre-defined distance is too small, fewer or no traces will be included into the section.

Section properties

The detailed properties of the profile are specified by choosing the menu `Seismic > Section Properties`.



Vertical section (Profile)

☑ Enable Start: X 216 m Y 4112 m

End: X 3886 m Y 1218 m

Length 4673.8 m

Azimuth -38 deg

Finder-circle (max distance from profile line to trace) 35 m

Horizontal slice

☑ Draw color map

Start: Z 1394 m

End: Z 1394 m

Curvature

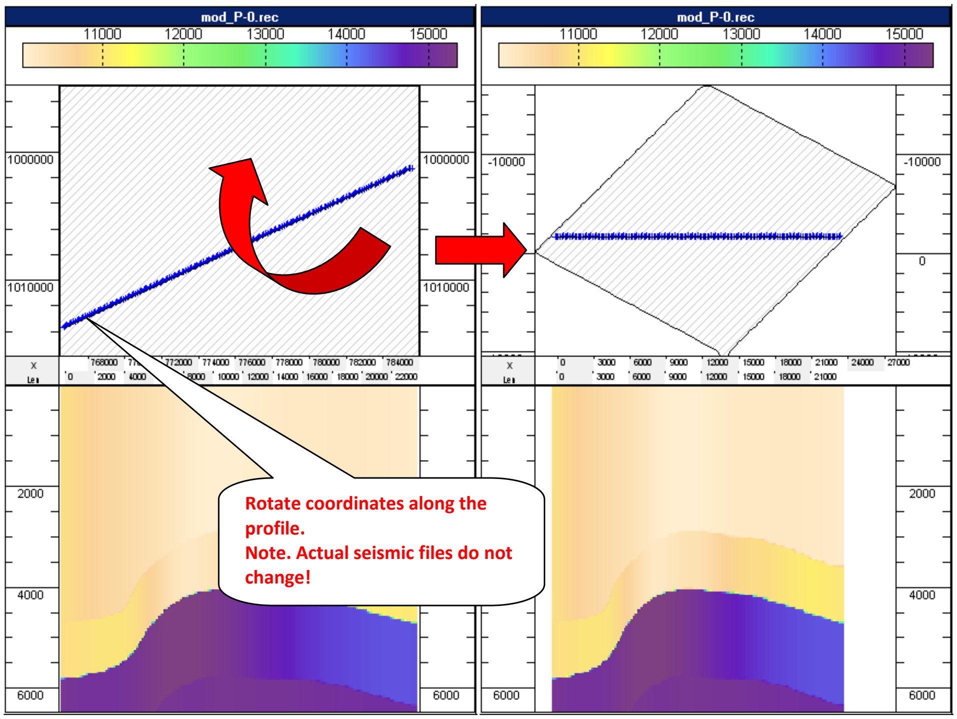
● Straight (Z=const)

○ From grid/surface file

In this box, the profile coordinates, its length and azimuth may be defined, as well as the maximum distance between profile and a trace.

A vertical section may be exported to a separate seismic file, which may be then used as an underlying image for a model. The menu `Run > Seismic Frame > Export Section to 2D Seismic File` is used.

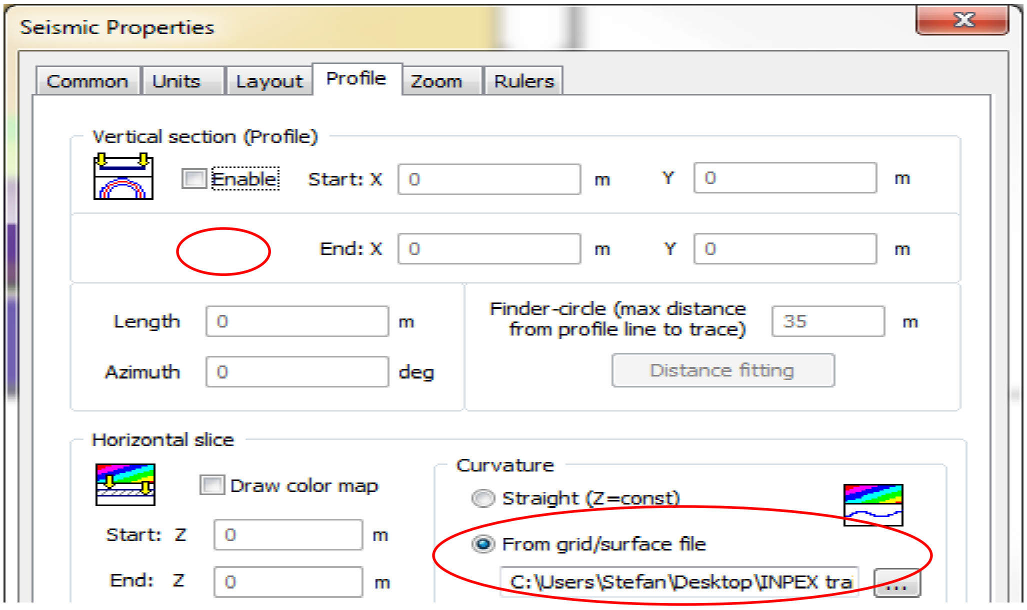
The seismic data loaded into a Frame may be rotated along the profile, by using the menu `Seismic > Rotate to Align X Axis along Section Profile`. But the content of the actual seismic files will not be modified as the rotation will only modify the corresponding auxiliary files with suffix ".cr0".


mod_P-0.rec
11000
12000
13000
14000
15000
1000000
1010000
2000
4000
6000
mod_P-0.rec
11000
12000
13000
14000
15000
-10000
0
2000
4000
6000

Rotate coordinates along the profile.
Note. Actual seismic files do not change!

13.6 Overlay surfaces on seismic cubes

You may load a surface and obtain the intersection line between this surface and a 3D cube. To do this, please specify the Seismic Frame's properties and specify the name of the file containing the surface.



Seismic Properties

Vertical section (Profile)

☐ Enable

Start: X 0 m Y 0 m

End: X 0 m Y 0 m

Length 0 m

Azimuth 0 deg

Finder-circle (max distance from profile line to trace) 35 m

Horizontal slice

☐ Draw color map

Start: Z 0 m

End: Z 0 m

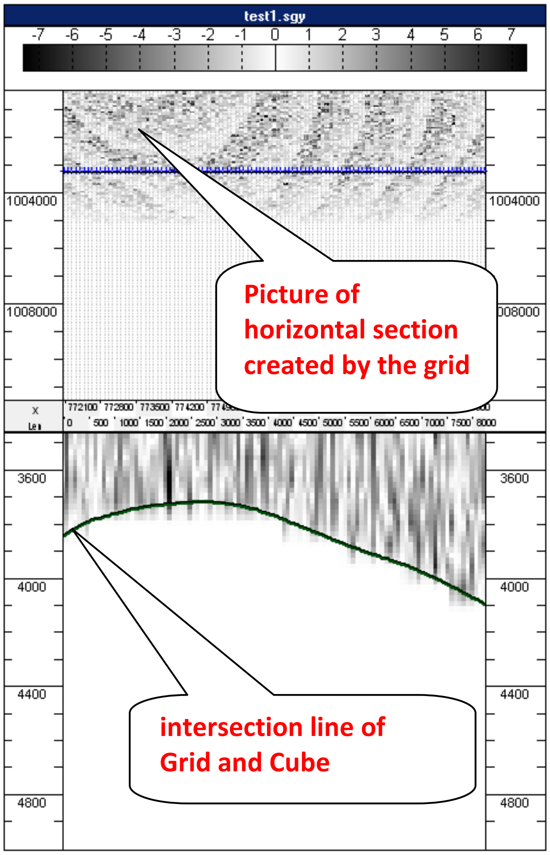
Curvature

○ Straight (Z=const)

● From grid/surface file

C:\Users\Stefan\Desktop\INPEX tra

Tesseral Pro supports loading surfaces in the following formats: XYV, CSV, DAT, Surfer, Schlumberger, Triple TXT, ZMap, Paradigm, GeoQuest, Landmark, Charisma-YX, Charisma-XY, ASC.



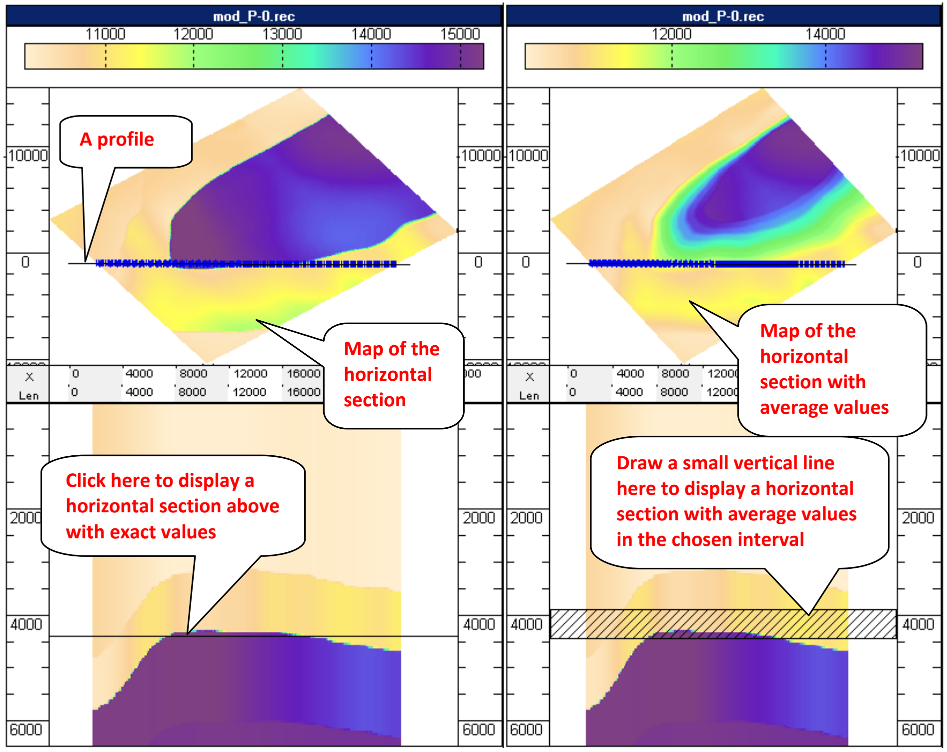
The intersection line between the surface and the cube is shown as dark green line in the vertical section.

While working in the Profile Drawing mode, when you click an arbitrary point on the vertical section, then a horizontal section will be created automatically such that it runs through the chosen point and is parallel to the loaded surface. This image will appear in the top view.

13.7 Horizontal sections

Tesseral Pro implements a rather unconventional (for other gather-viewing software) mode for displaying horizontal slices. This mode is useful for 2D visualization of the raster 3D cubes.

In the figure below, the horizontal (above) and the vertical (below) sections of the raster 3D velocity model are shown. In these sections, the profiles lines are shown, along which the horizontal/vertical sections were created. The profile line in the horizontal section is for creating a vertical section, and vice versa.


mod_P-0.rec
11000 12000 13000 14000 15000
mod_P-0.rec
12000 14000
A profile
Map of the horizontal section
Map of the horizontal section with average values
Click here to display a horizontal section above with exact values
Draw a small vertical line here to display a horizontal section with average values in the chosen interval
X
Len
10000
0
2000
4000
6000

To build a horizontal section, just switch to the drawing mode and click on an arbitrary point in the vertical section. Then, the horizontal section passing through the given point will be created automatically and displayed in the top view (see the top image). If a vertical line is drawn in the vertical section, a horizontal section will be created, whose value at each position is the average value spanning the drawn line (see the bottom image). The area, for which the horizontal section is created, will be shown by hatching.

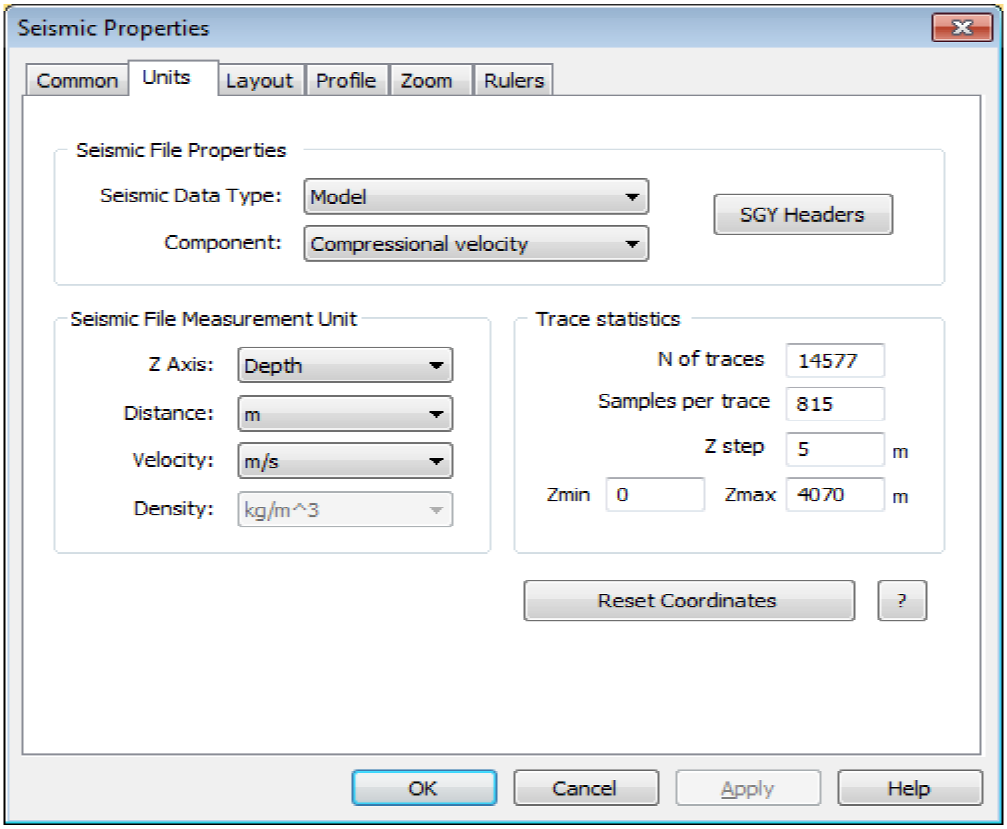
To remove the horizontal section while in the drawing mode, please click an arbitrary point in the vertical section while pressing “`Ctrl`” button.

13.8 Settings for Seismic Frame

The majority of the visualization options can be accessed in the Seismic Frame settings. The parameters for displaying gather are specified in the `Seismic Frame Properties` tab under the `Seismic` menu.

The properties dialog box is divided into several tabs. In the “`Common`” tab, the general properties for the visualization of the object are specified, and in the “`Layout`” tab, where the parameters for visualization of the acquisition surface are defined.

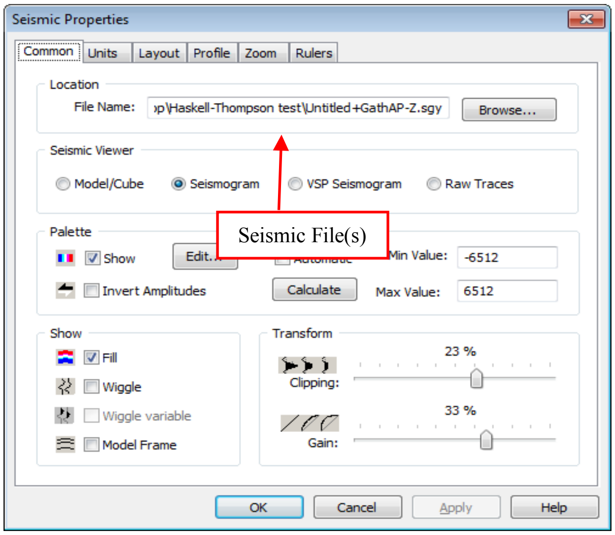
The `Units` tab in the `Seismic Properties` window is for changing (scaling) the coordinates and values of the trace data in case a gather is displayed incorrectly in the Frame. In this case, the original file is not modified, and the changes are saved into an additional file **<seismogram_file_name>.cr0**. These new modified values will be loaded next time the file is opened.


Seismic Properties
Common
Units
Layout
Profile
Zoom
Rulers
Seismic File Properties
SGY Headers
Seismic File Measurement Unit
Trace statistics
Reset Coordinates
?
OK
Cancel
Apply
Help

Seismic Data Type: Model
Component: Compressional velocity
Z Axis: Depth
Distance: m
Velocity: m/s
Density: kg/m^3
N of traces: 14577
Samples per trace: 815
Z step: 5 m
Zmin: 0
Zmax: 4070 m

If you need to restore the trace parameters and coordinates, please delete the corresponding **<seismogram_file_name>.cr0** file.

You can change color representation for displaying seismic data. The package includes 10 standard palettes (blue-yellow-magenta, iridescent, black-white and etc.).You can create a custom palette by clicking on `Edit` button in `Common` tab. The minimal and the maximal values for the color palette may be specified manually or left for the program to calculate these values automatically (for each vertical section and for the whole dataset).


Seismic Properties
Common
Units
Layout
Profile
Zoom
Rulers
Browse...
Edit...
Automatic
Calculate
OK
Cancel
Apply
Help

Location

File Name: ›p\Haskell-Thompson test\Untitled+GathAP-Z.sgy

Seismic Viewer

○ Model/Cube ● Seismogram ○ VSP Seismogram ○ Raw Traces

Seismic File(s)

Palette

☑ Show

☐ Invert Amplitudes

Min Value: -6512

Max Value: 6512

Show

☑ Fill

☐ Wiggle

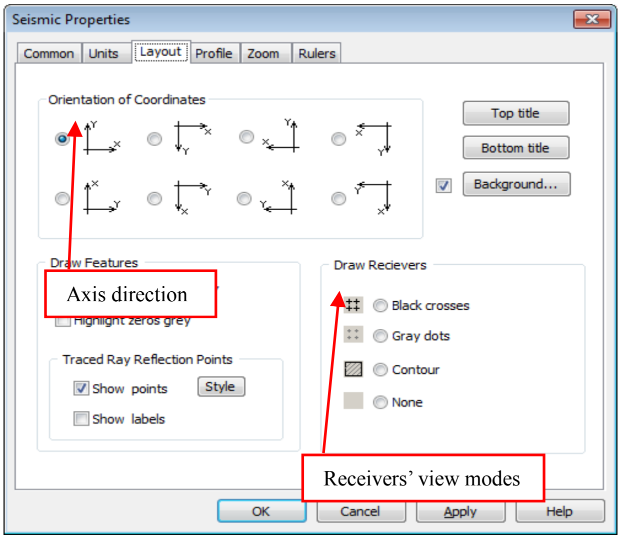
☐ Wiggle variable

☐ Model Frame

Transform

Clipping: 23 %

Gain: 33 %


Seismic Properties
Common
Units
Layout
Profile
Zoom
Rulers
Orientation of Coordinates
Top title
Bottom title
Background...
Style
OK
Cancel
Apply
Help

☑ Background...

Axis direction

Draw Features

☐ Highlight zeros grey

Traced Ray Reflection Points

☑ Show points

☐ Show labels

Draw Recievers

○ Black crosses

○ Gray dots

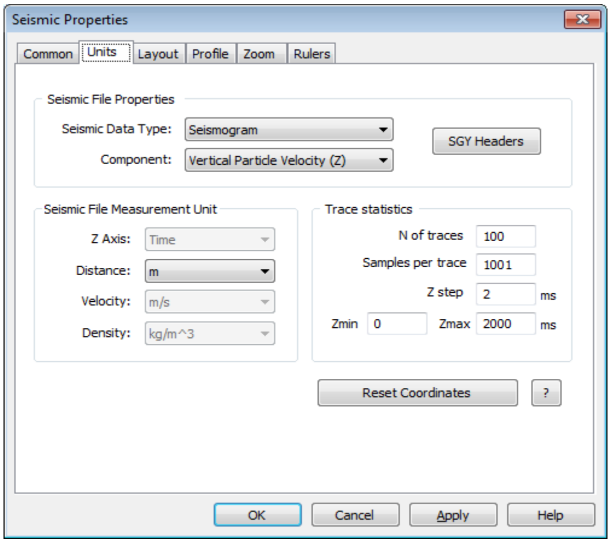
○ Contour

○ None

Receivers’ view modes

In the `Layout` tab, it is possible to define the parameters for visualizing the acquisition system. In the drop-down list of `Seismic viewer` from the `Common` tab you may select the display mode for the acquisition system. These modes are described in more details below.

For different seismic files, the number of the receivers may vary from hundreds to millions, and therefore several ways of displaying these receivers are implemented, such as small black crosses, grey dots and contours.


Seismic Properties
Common
Units
Layout
Profile
Zoom
Rulers
SGY Headers
Reset Coordinates
?
OK
Cancel
Apply
Help

Seismic File Properties

Seismic Data Type: Seismogram

Component: Vertical Particle Velocity (Z)

Seismic File Measurement Unit

Z Axis: Time

Distance: m

Velocity: m/s

Density: kg/m^3

Trace statistics

N of traces 100

Samples per trace 1001

Z step 2 ms

Zmin 0

Zmax 2000 ms

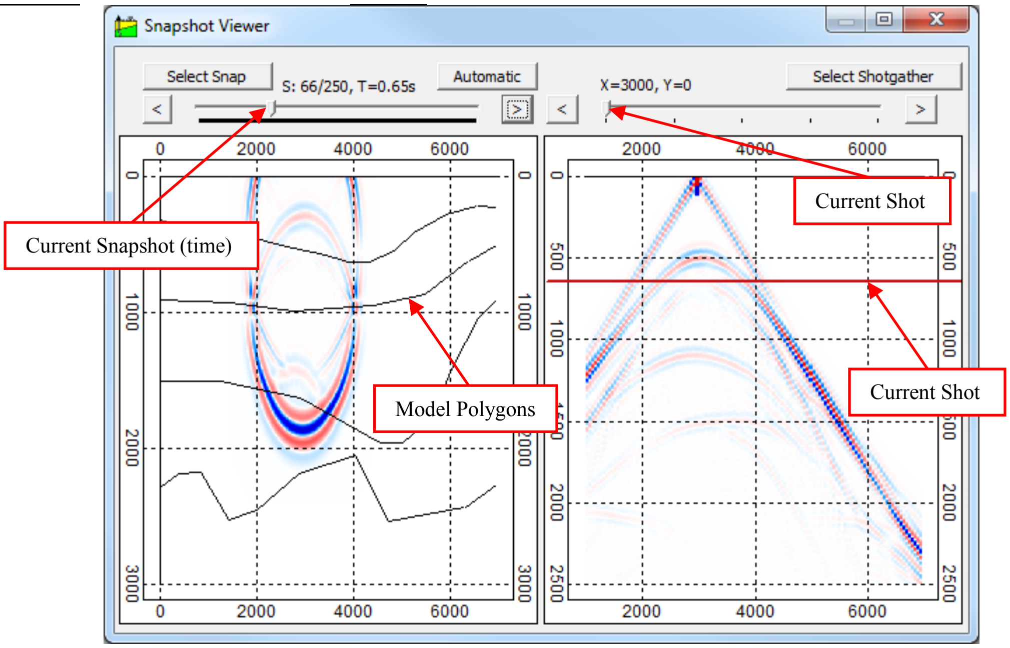
The `Common` tab also allows adjusting the traces displayed in the vertical section. In the `Show` group, users can select whether the traces will be displayed as wiggle or image based on the user-defined palette. For multi-component seismic data, users can select the component to be displayed in the `Seismic File Properties` group from the `Units` tab.

In the Rulers tab, the parameters for displaying the Vertical and Horizontal rulers are specified. By default, both rulers are shown on the left and the right side of the object, but users have the option to either display the vertical scale on the left side, or just on the right side. .

The profile parameters (vertical or horizontal section) can be defined in `Profile` tab.

13.9 2D Snapshot Viewer

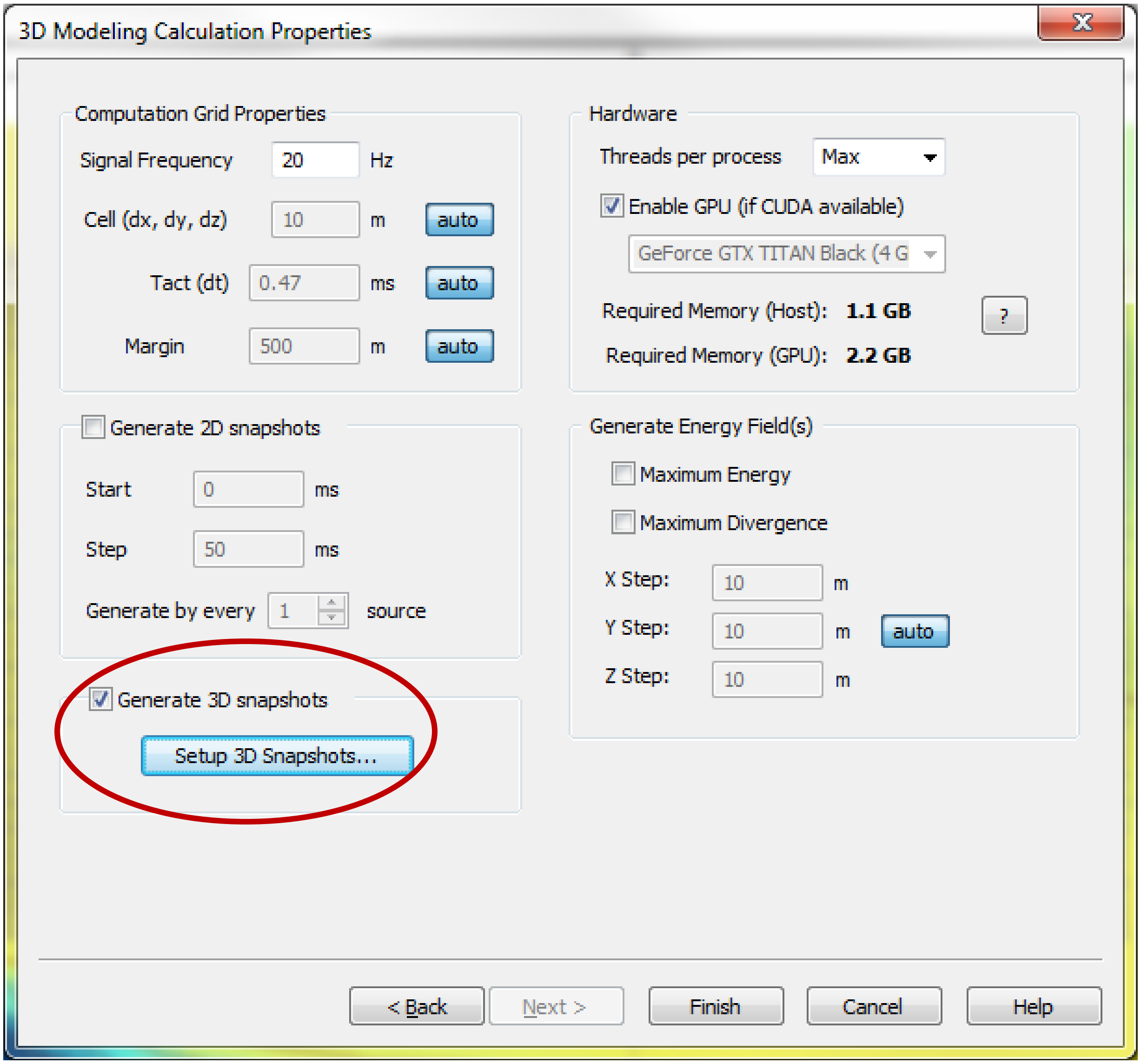
To show the snapshots together with the shot gather, please choose the `Snapshot View Window` command under the `View` menu.


Snapshot Viewer
Select Snap
S: 66/250, T=0.65s
Automatic
X=3000, Y=0
Select Shotgather
Current Snapshot (time)
Current Shot
Model Polygons
Current Shot
0
2000
4000
6000
1000
3000
500
2500

Please press the `Select Snap` button to select the file with a snapshot. Please press the `Select Shotgather` button to select the corresponding gathers. If the Model Frame is opened in the Tesseral Pro, the contours of the model will be shown in the snapshot. Navigation through snapshots and gathers is done with help of the corresponding sliders.

13.10 3D Snapshot Viewer

In order to generate 3D snapshots please select check `Generate 3D snapshots` and select `Setup 3D Snapshots` in the `3D modelling Calculations Properties` window.


3D Modeling Calculation Properties

Computation Grid Properties

Signal Frequency 20 Hz

Cell (dx, dy, dz) 10 m

Tact (dt) 0.47 ms

Margin 500 m

Hardware

Threads per process Max

☑ Enable GPU (if CUDA available)

GeForce GTX TITAN Black (4 G

Required Memory (Host): **1.1 GB**

Required Memory (GPU): **2.2 GB**

☐ Generate 2D snapshots

Start 0 ms

Step 50 ms

Generate by every 1 source

Generate Energy Field(s)

☐ Maximum Energy

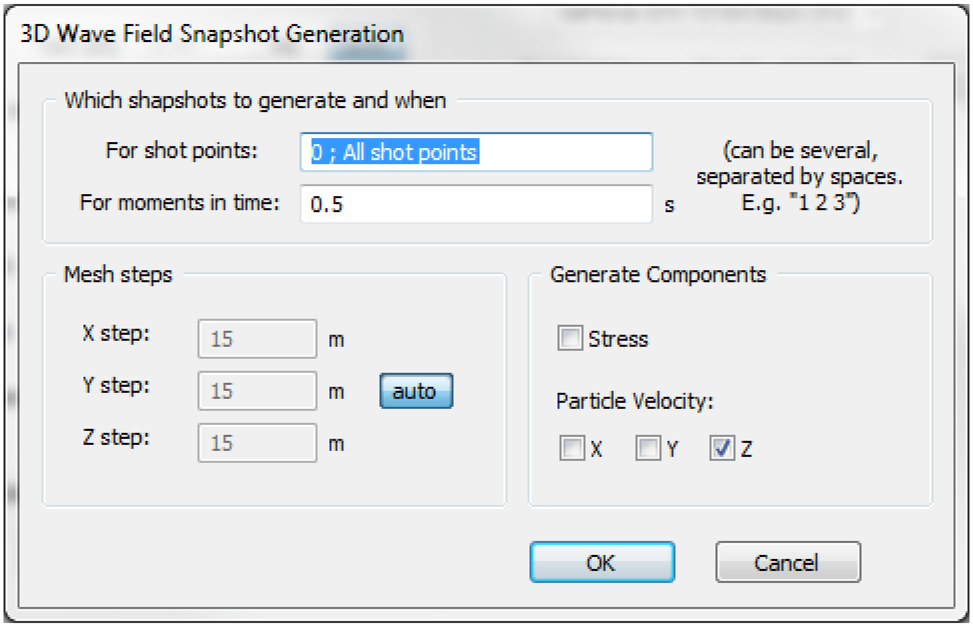
☐ Maximum Divergence

X Step: 10 m

Y Step: 10 m

Z Step: 10 m

☑ Generate 3D snapshots


3D Wave Field Snapshot Generation

Which shapshots to generate and when

For shot points: 0 ; All shot points

For moments in time: 0.5 s

(can be several, separated by spaces. E.g. "1 2 3")

Mesh steps

X step: 15 m

Y step: 15 m

Z step: 15 m

Generate Components

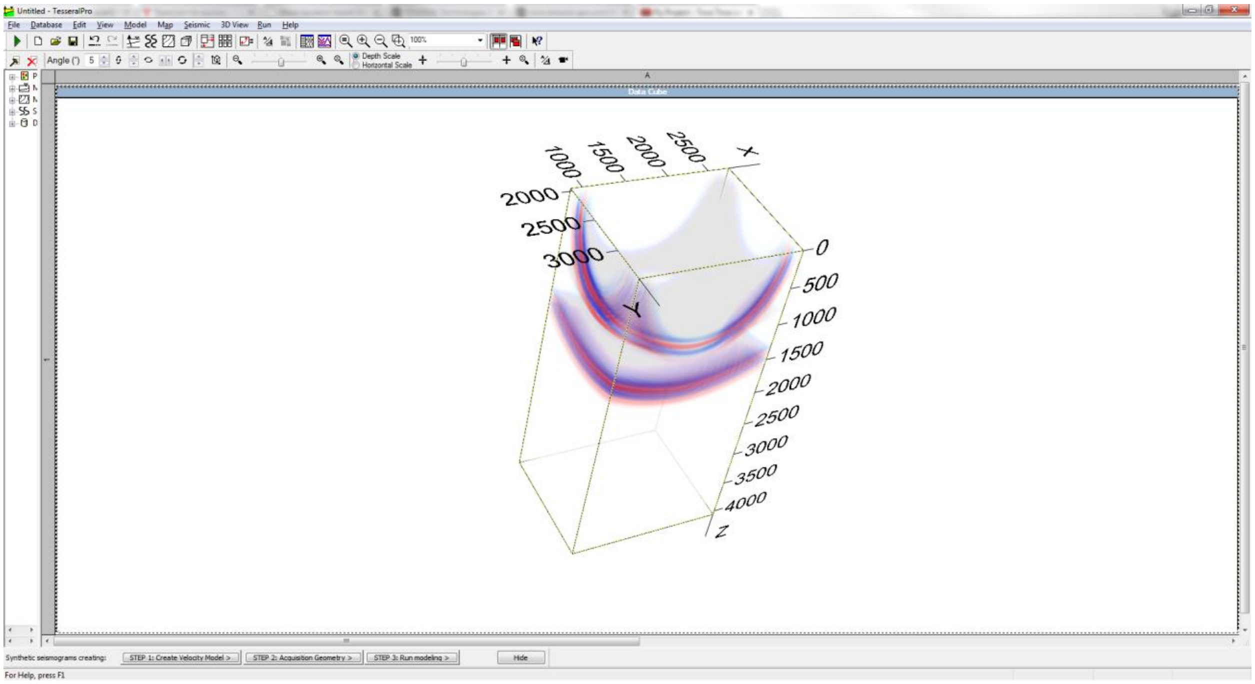
☐ Stress

Particle Velocity:

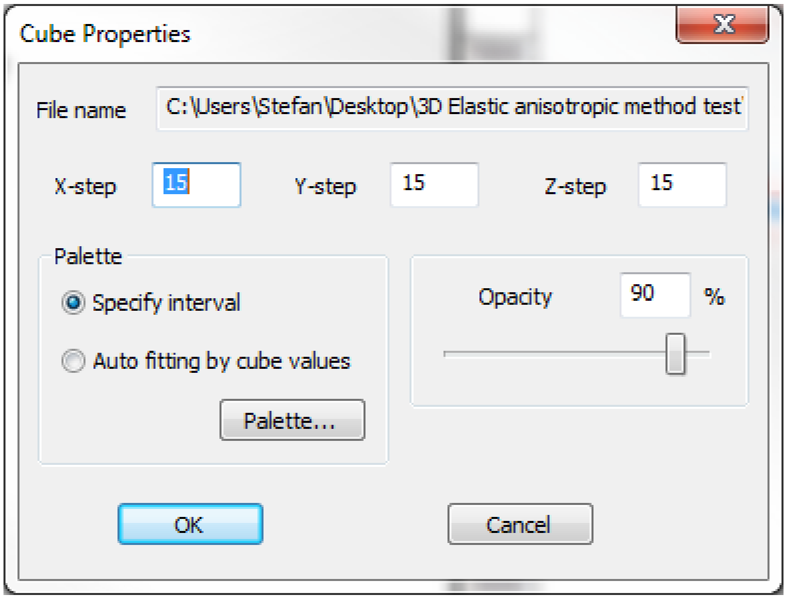
☐ X ☐ Y ☑ Z

auto
OK
Cancel

The user then needs to specify the `Shot Points` and the `Component` for which snapshots need to be generated, as well as for which `Moments in Time`. The user can also adjust the default values for the `Mesh Step` for wave field propagations along the X, Y and Z axis.


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
Data Cube
1000
1500
2000
2500
X
2000
2500
3000
Y
0
500
1000
1500
2000
2500
3000
3500
4000
Z
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

As a result a SGY file will be generated for each specified shot point and its respective component, which will contain a snapshot image of the propagating wavefield at the specified time. In order to view the snapshot, the generated SGY file needs to be opened in `3D View` frame (`3D View>Add SEG-Y cube`). In order to achieve the best display, the user will need to adjust the visualization parameters in the `3D View>Selected object properties` window.


Cube Properties
OK
Cancel
Palette...

File name C:\Users\Stefan\Desktop\3D Elastic anisotropic method test

X-step 15 Y-step 15 Z-step 15

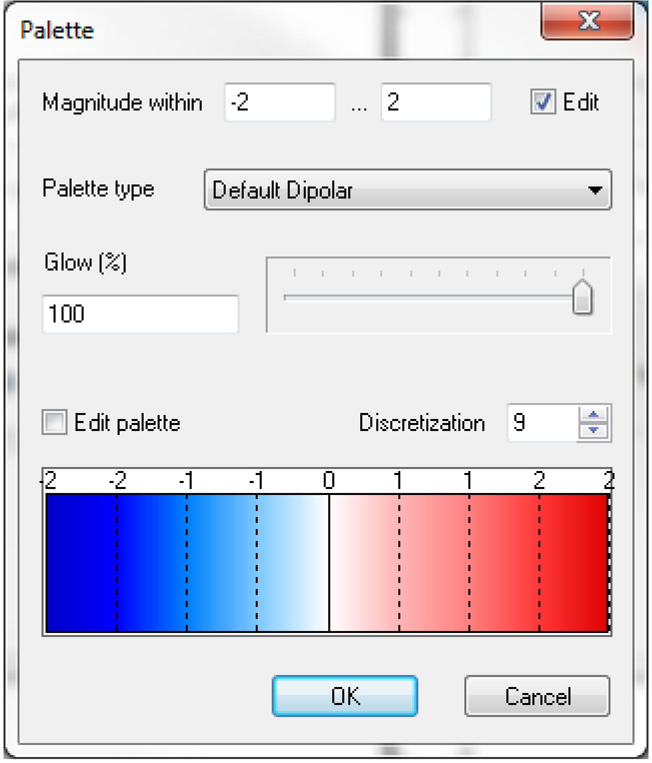
Palette

● Specify interval

○ Auto fitting by cube values

Opacity 90 %

Typically for an optimum visualization of the wavefield, a value 85%-95% for the `Opacity` works best. Also, reducing the `Magnitude within the Palette` will also enhance the display of the whole wavefield.


Palette
-2
-2
-1
-1
0
1
1
2
2
OK
Cancel

Magnitude within -2 ... 2 ☑ Edit

Palette type Default Dipolar

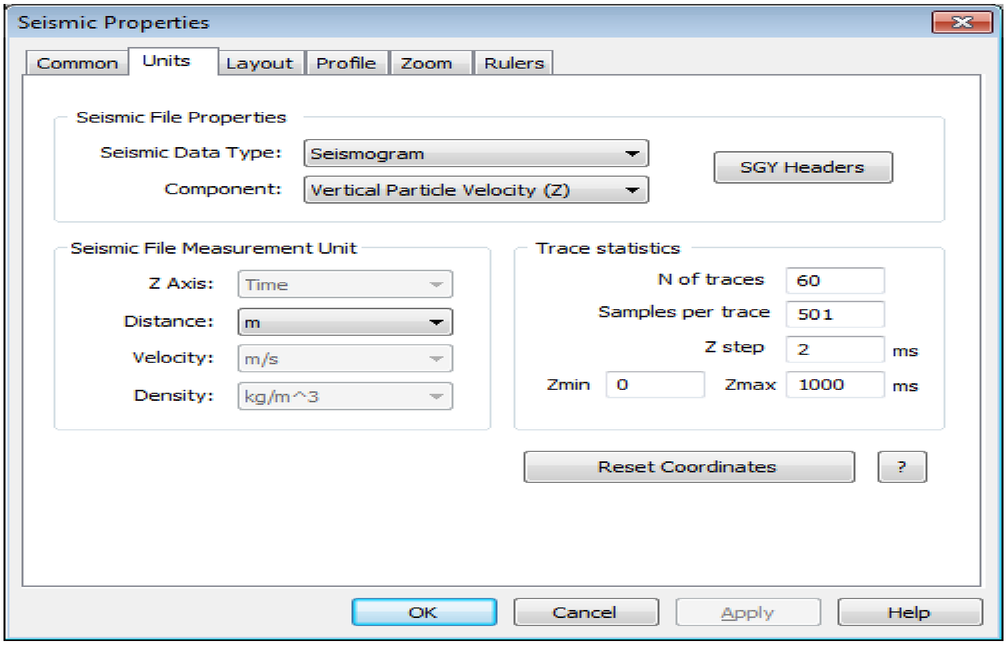
Glow (%) 100

☐ Edit palette

Discretization 9

13.11 Prepare seismic files for loading

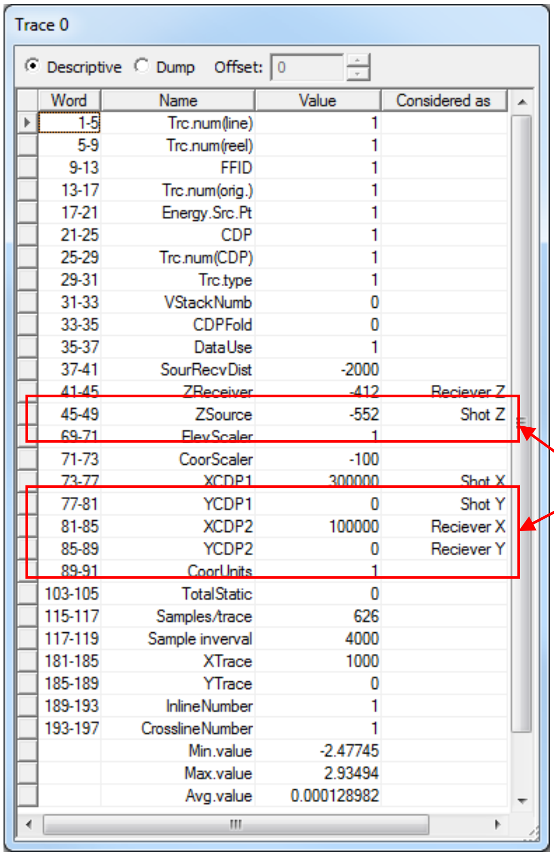
Sometimes, for unconventional gathers, some preliminary preparation is necessary before loading. Most often, the problems with loading SEG-Y files are caused by incorrect reading of the data related to the timing of the signal registration and incorrect reading of the data related to coordinates and altitude of sources and receivers. Partially, these problems can be solved in the `Seismic Properties` dialogue box (the `Seismic > Seismic Frame Properties` command)..


Seismic Properties
Common
Units
Layout
Profile
Zoom
Rulers
Seismic File Properties
SGY Headers
Seismic File Measurement Unit
Trace statistics
Reset Coordinates
?
OK
Cancel
Apply
Help

Seismic Data Type: Seismogram
Component: Vertical Particle Velocity (Z)
Z Axis: Time
Distance: m
Velocity: m/s
Density: kg/m^3
N of traces 60
Samples per trace 501
Z step 2 ms
Zmin 0 Zmax 1000 ms

In the `Seismic File Properties` dialogue box, please select the measurement units for scaling of the trace coordinates and of the trace interval. In this case, the content of the gathers itself will be not be changed. All changes will be saved in an auxiliary file named **<name of the gather file>.cr0**. If you press the `Apply` button in the `Seismic File Properties` dialogue box, the file with the suffix .cr0 will be deleted and the previously entered scaling constants will be cleared.

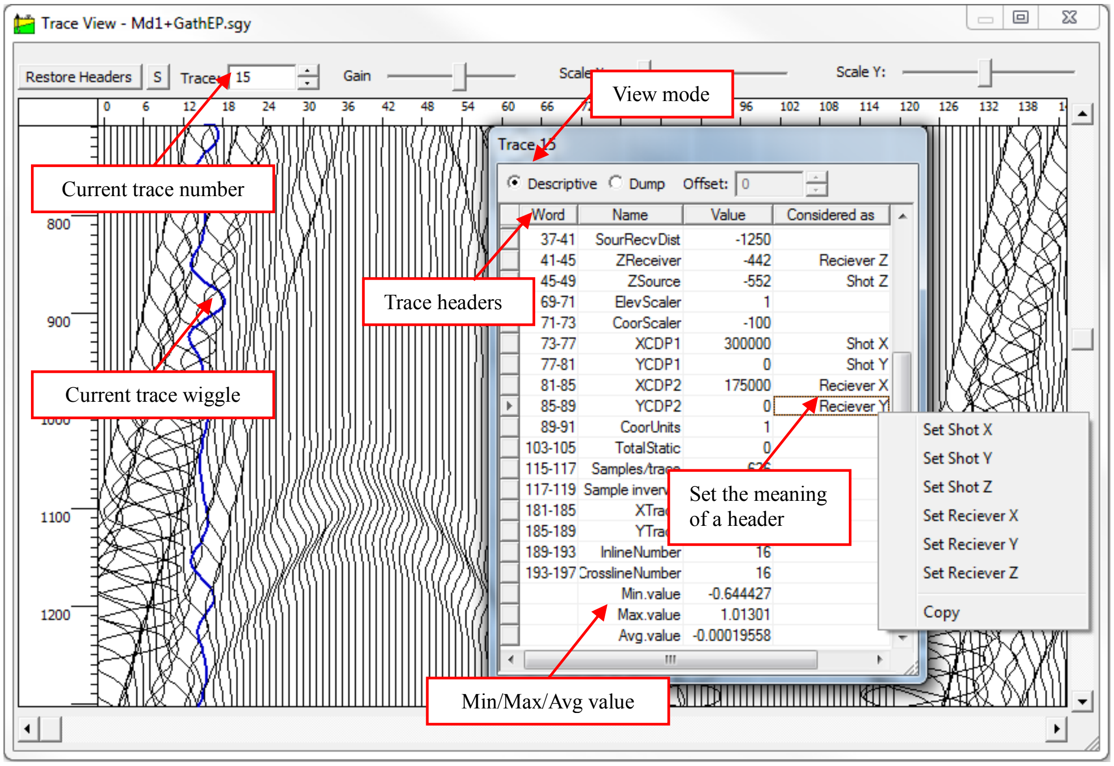
Sometimes, the trace coordinates in a SEG-Y file's header are located in non-standard cells.


Trace 0
● Descriptive ○ Dump Offset: 0

Word	Name	Value	Considered as
1-5	Trc.num(line)	1	
5-9	Trc.num(reel)	1	
9-13	FFID	1	
13-17	Trc.num(orig.)	1	
17-21	Energy.Src.Pt	1	
21-25	CDP	1	
25-29	Trc.num(CDP)	1	
29-31	Trc.type	1	
31-33	VStackNumb	0	
33-35	CDPFold	0	
35-37	DataUse	1	
37-41	SourRecvDist	-2000	
41-45	ZReceiver	-412	Reciever Z
45-49	ZSource	-552	Shot Z
69-71	ElevScaler	1	
71-73	CoorScaler	-100	
73-77	XCDP1	300000	Shot X
77-81	YCDP1	0	Shot Y
81-85	XCDP2	100000	Reciever X
85-89	YCDP2	0	Reciever Y
89-91	CoorUnits	1	
103-105	TotalStatic	0	
115-117	Samples/trace	626	
117-119	Sample inverval	4000	
181-185	XTrace	1000	
185-189	YTrace	0	
189-193	InlineNumber	1	
193-197	CrosslineNumber	1	
	Min.value	-2.47745	
	Max.value	2.93494	
	Avg.value	0.000128982	

The standard locations of source's and receiver's X/Y/Z coordinates in a SEG-Y file's header

To prepare a gather for loading, please choose the `Seismic > Raw Trace View Window` command. After the seismic file is chosen, 2 windows will be opened. In one of the windows, the trace preview is shown in the same order as the traces in the file, and in the second window, the table with headers of an individual trace is shown.


Trace View - Md1+GathEP.sgy
Restore Headers
S
Trace 15
Gain
Scale X:
Scale Y:
0
6
12
18
24
30
36
42
48
54
60
66
72
96
102
108
114
120
126
132
138
800
900
1000
1100
1200
Trace 15
● Descriptive ○ Dump Offset: 0

Current trace number

View mode

Trace headers

Current trace wiggle

Word	Name	Value	Considered as
37-41	SourRecvDist	-1250	
41-45	ZReceiver	-442	Reciever Z
45-49	ZSource	-552	Shot Z
69-71	ElevScaler	1	
71-73	CoorScaler	-100	
73-77	XCDP1	300000	Shot X
77-81	YCDP1	0	Shot Y
81-85	XCDP2	175000	Reciever X
85-89	YCDP2	0	Reciever Y
89-91	CoorUnits	1	
103-105	TotalStatic	0	
115-117	Samples/trac	62	
117-119	Sample inverv		
181-185	XTrac		
185-189	YTrac		
189-193	InlineNumber	16	
193-197	CrosslineNumber	16	
	Min.value	-0.644427	
	Max.value	1.01301	
	Avg.value	-0.00019558	

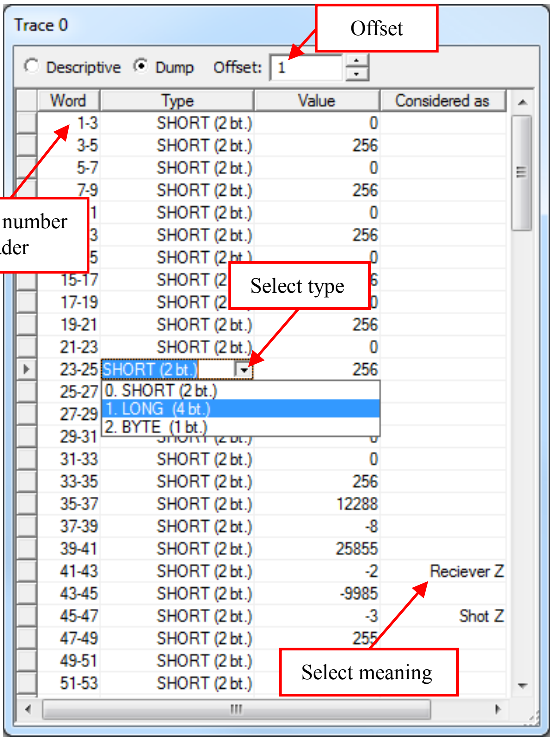
Set Shot X
Set Shot Y
Set Shot Z
Set Reciever X
Set Reciever Y
Set Reciever Z
Copy

Set the meaning of a header

Min/Max/Avg value

The key point for preparing a seismic file for loading is to select the headers' cells which correspond to the coordinates of the source and receiver. It is possible to allocate the coordinates of the source and the receiver to any cell in the headers by clicking the right mouse button in any cell of the header. This information (assign some header cells to the coordinates) will be saved in the file **<name of the gather file>.inf**, and, from now on, it will be used by the program.

Preview of all the trace headers enables to look through the trace headers as a set of values without name. You may specify the parameter offset to shift the starting point of displaying the headers.



Trace 0

○ Descriptive ● Dump Offset: 1

Word	Type	Value	Considered as
1-3	SHORT (2 bt.)	0	
3-5	SHORT (2 bt.)	256	
5-7	SHORT (2 bt.)	0	
7-9	SHORT (2 bt.)	256	
1	SHORT (2 bt.)	0	
3	SHORT (2 bt.)	256	
5	SHORT (2 bt.)	0	
15-17	SHORT (2	6	
17-19	SHORT (2	0	
19-21	SHORT (2 bt.)	256	
21-23	SHORT (2 bt.)	0	
23-25	SHORT (2 bt.)	256	
25-27			
27-29			
29-31			
31-33	SHORT (2 bt.)	0	
33-35	SHORT (2 bt.)	256	
35-37	SHORT (2 bt.)	12288	
37-39	SHORT (2 bt.)	-8	
39-41	SHORT (2 bt.)	25855	
41-43	SHORT (2 bt.)	-2	Reciever Z
43-45	SHORT (2 bt.)	-9985	
45-47	SHORT (2 bt.)	-3	Shot Z
47-49	SHORT (2 bt.)	255	
49-51	SHORT (2 bt.)		
51-53	SHORT (2 bt.)		

0. SHORT (2 bt.)
1. LONG (4 bt.)
2. BYTE (1 bt.)

The trace header may be displayed in two modes: Descriptive mode and Dump mode. In the Descriptive mode, only the headers with known names are listed. In the Dump mode, all headers are listed.

While looking through the header as a whole, the location of words is in the first column, the data type is in the 2nd column and the values are shown in the third column. As different data types have different length of words, the lower part of the header is shifted automatically.

Tesseral Pro supports the following data types: CHAR (1 byte, -127~128), SHORT (2 bytes, -32767~32768), LONG (4 bytes, -2147483647~2147483648).

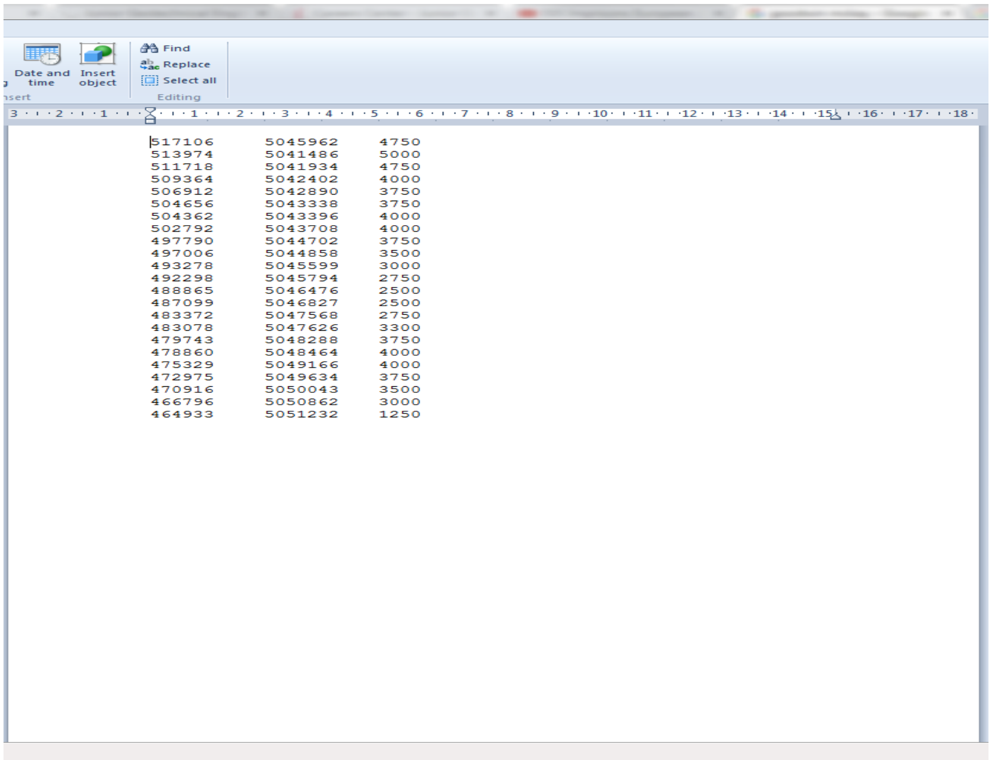
14 Map Frame

In Tesseral Pro, a model can be built from stratigraphic surface maps. The model is built automatically as a vertical slice cutting through the calculated (loaded) surfaces vertically along the selected line. More information about building models by using stratigraphic surfaces is described below. Firstly, let’s describe the relevant capabilities for loading, calculating, displaying and processing surfaces.

14.1 Load surface from text file

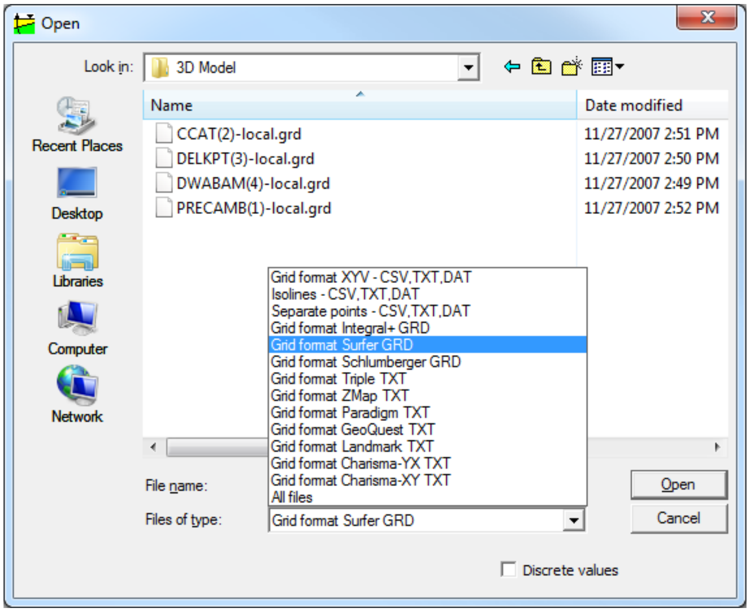
Tesseral Pro supports loading surface from text files in various formats (the command `File > Load Surface File`). It is also possible to load grids in the following formats: XYV, isolines, separate points, Integral+, Surfer, Schlumberger, Triple, ZMap, Paradigm, GeoQuest, Landmark and Charisma.

The user can also generate surfaces on his own, by introducing in a text file the XYZ coordinates of the surface in 3 separate columns and then saving the file with an XYZ extension.



```
517106      5045962     4750
513974      5041486     5000
511718      5041934     4750
509364      5042402     4000
506912      5042890     3750
504656      5043338     3750
504362      5043396     4000
502792      5043708     4000
497790      5044702     3750
497006      5044858     3500
493278      5045599     3000
492298      5045794     2750
488865      5046476     2500
487099      5046827     2500
483372      5047568     2750
483078      5047626     3300
479743      5048288     3750
478860      5048464     4000
475329      5049166     4000
472975      5049634     3750
470916      5050043     3500
466796      5050862     3000
464933      5051232     1250
```

In the standard `File Open` dialogue box, please select the surface file and specify the proper format from the `File type` list for the selected surface file.


Open
Recent Places
Desktop
Libraries
Computer
Network
Grid format XYV - CSV,TXT,DAT
Isolines - CSV,TXT,DAT
Separate points - CSV,TXT,DAT
Grid format Integral+ GRD
Grid format Surfer GRD
Grid format Schlumberger GRD
Grid format Triple TXT
Grid format ZMap TXT
Grid format Paradigm TXT
Grid format GeoQuest TXT
Grid format Landmark TXT
Grid format Charisma-YX TXT
Grid format Charisma-XY TXT
All files
Open
Cancel

Look in: 3D Model

Name	Date modified
CCAT(2)-local.grd	11/27/2007 2:51 PM
DELKPT(3)-local.grd	11/27/2007 2:50 PM
DWABAM(4)-local.grd	11/27/2007 2:49 PM
PRECAMB(1)-local.grd	11/27/2007 2:52 PM

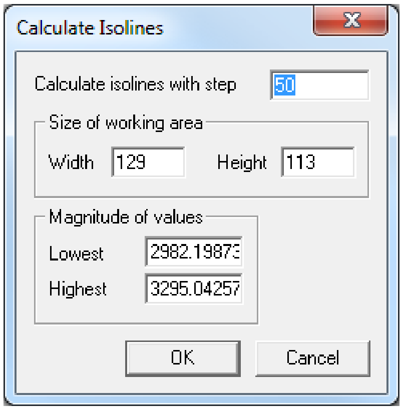
File name:

Files of type: Grid format Surfer GRD

☐ Discrete values

You may select several files of the same type for a group loading.

Then, in the next dialogue box `Calculate Isolines`, please specify the parameters for calculating the isolines or click `Cancel`, if you do not want isolines to be shown on the surface.


Calculate Isolines
OK
Cancel

Calculate isolines with step: 50

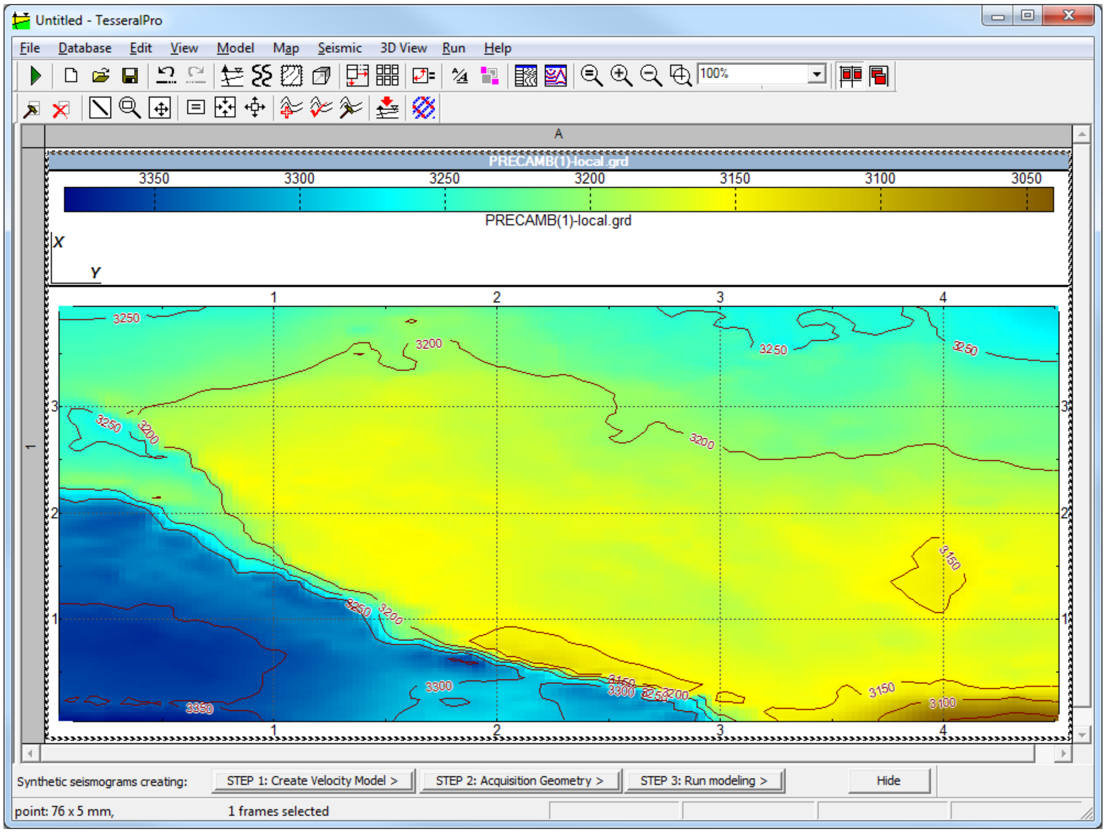
Size of working area

Width: 129
Height: 113

Magnitude of values

Lowest: 2982.1987
Highest: 3295.04257

Please see the results


Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
A
PRECAMB(1)-local.grd
3350
3300
3250
3200
3150
3100
3050
PRECAMB(1)-local.grd
X
Y
1
2
3
4
3250
3200
3150
3100
3300
3350
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 76 x 5 mm,
1 frames selected

Please repeat this operation to load other surfaces.

Tesseral Pro saves all loaded surfaces as a general block in a Tesseral Pro document. Please use the `Map` Frame to display a surface. While deleting the `Map` Frame, the last showed surface in this Frame is not deleted and it will remain in the block of the calculated (loaded) surfaces in the Tesseral Pro document. You can show this surface in another `Map Frame` by selecting it from a list. Please use `Map > Manage/Delete surface` to manage the surfaces loaded in Tesseral Pro. More detailed information can be found in the Section *14.2.5*.

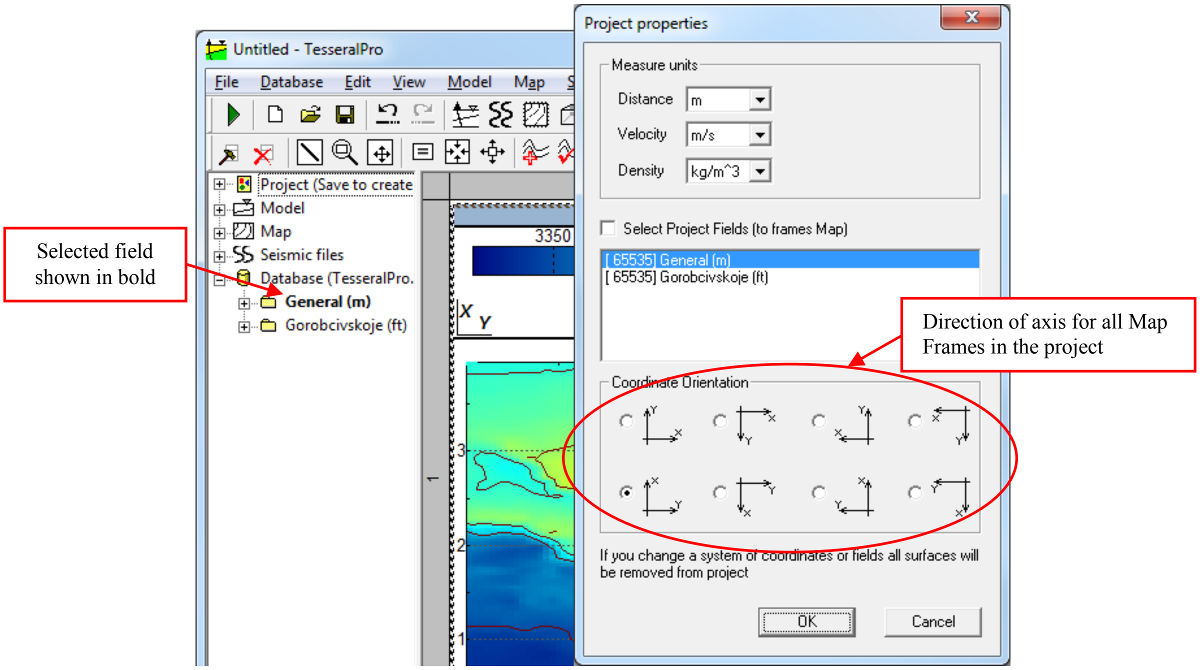
NOTE: The `Undo` and `Redo` commands do not apply to actions performed on surfaces (loading, calculating, processing, deleting), but they do work for the changes related to the `Map` Frame (selecting a surface for display, color adjustments, scaling, Frame re-size and etc).

14.2 Calculate surfaces using well data

To build surfaces by using the intersection of well layers, Tesseral Pro requires an existing MS Access or MS SQL Server database with well coordinates, altitudes and/or inclinometry and stratigraphic well depth values. More detailed information about how to load such information into the geophysical database can be found below in the Section *17*.

14.2.1 Select fields for the project

As the database may include several independent fields, users need to select the "working" field before surface building, which can be done using the command `File > Project Properties`. Please also select the directions of the coordinate axis for the surface maps you want to build.



Selected field shown in bold

Direction of axis for all Map Frames in the project

Measure units

Distance: m

Velocity: m/s

Density: kg/m^3

☐ Select Project Fields (to frames Map)

[65535] General (m)

[65535] Gorobcivskoje (ft)

If you change a system of coordinates or fields all surfaces will be removed from project

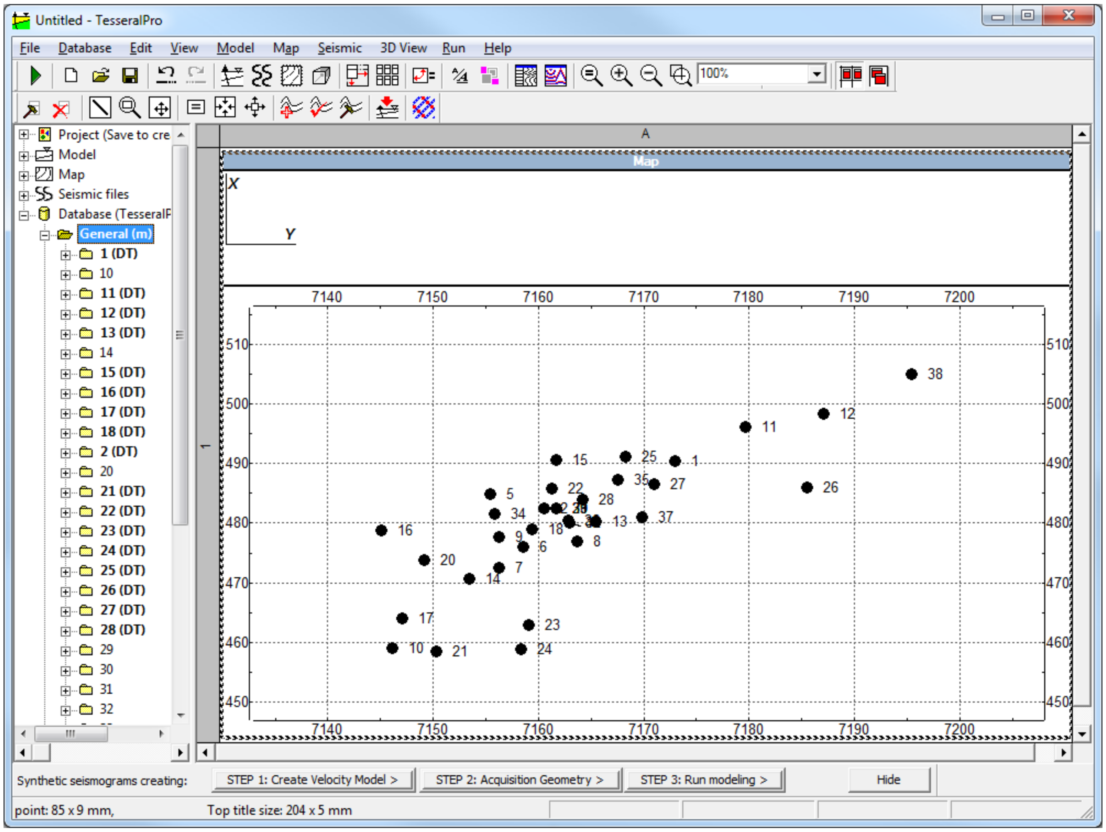
Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Project (Save to create
Model
Map
Seismic files
Database (TesseralPro.
General (m)
Gorobcivskoje (ft)
3350
X
Y
Project properties
Coordinate Orientation
OK
Cancel

NOTE: Once Tesseral Pro is loaded, it is not yet connected to the database. Please use the `Load Database` button in the left part of the window to connect to DBMS MS SQL Server or to MS Access and to load the Tesseral Pro database. More information about connecting to the database can be found in the Section *17.4*.

NOTE: It is also possible to select a field using the command `Select a field for the project` from the context menu by right-clicking the mouse on the field's name in the database tree.

14.2.2 Create Frame Map

Please use the command `Map > Create Map (New Frame)`.
Then, a map with the wells of the selected field will appear.

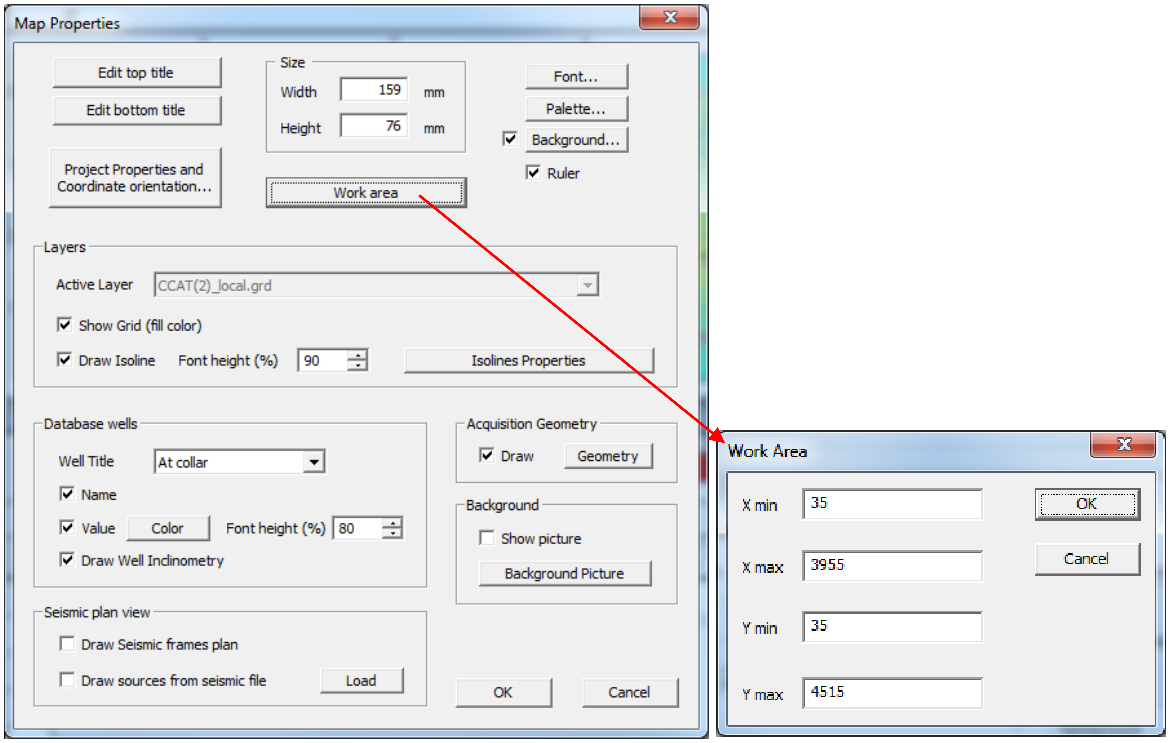

Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Project (Save to cre
Model
Map
Seismic files
Database (TesseralP
General (m)
1 (DT)
10
11 (DT)
12 (DT)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
24 (DT)
25 (DT)
26 (DT)
27 (DT)
28 (DT)
29
30
31
32
A
Map
X
Y
7140 7150 7160 7170 7180 7190 7200
510 500 490 480 470 460 450
38
11
12
15
25
1
35
27
26
5
22
28
34
13
37
16
18
8
9
6
20
7
14
17
23
10
21
24
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

point: 85 x 9 mm, Top title size: 204 x 5 mm

All commands for editing the map are located in the `Map` menu.

14.2.3 Working area

The working area (the area where the surface is built) is defined by an interval (m or ft) along the X and Y axis. The working area is defined in the `Map Properties` dialogue box of the `Map` Frame.



Map Properties

Size
Width 159 mm
Height 76 mm

☑ Background...
☑ Ruler

Layers
Active Layer CCAT(2)_local.grd
☑ Show Grid (fill color)
☑ Draw Isoline Font height (%) 90

Database wells
Well Title At collar
☑ Name
☑ Value Font height (%) 80
☑ Draw Well Inclinometry

Acquisition Geometry
☑ Draw

Background
☐ Show picture

Seismic plan view
☐ Draw Seismic frames plan
☐ Draw sources from seismic file

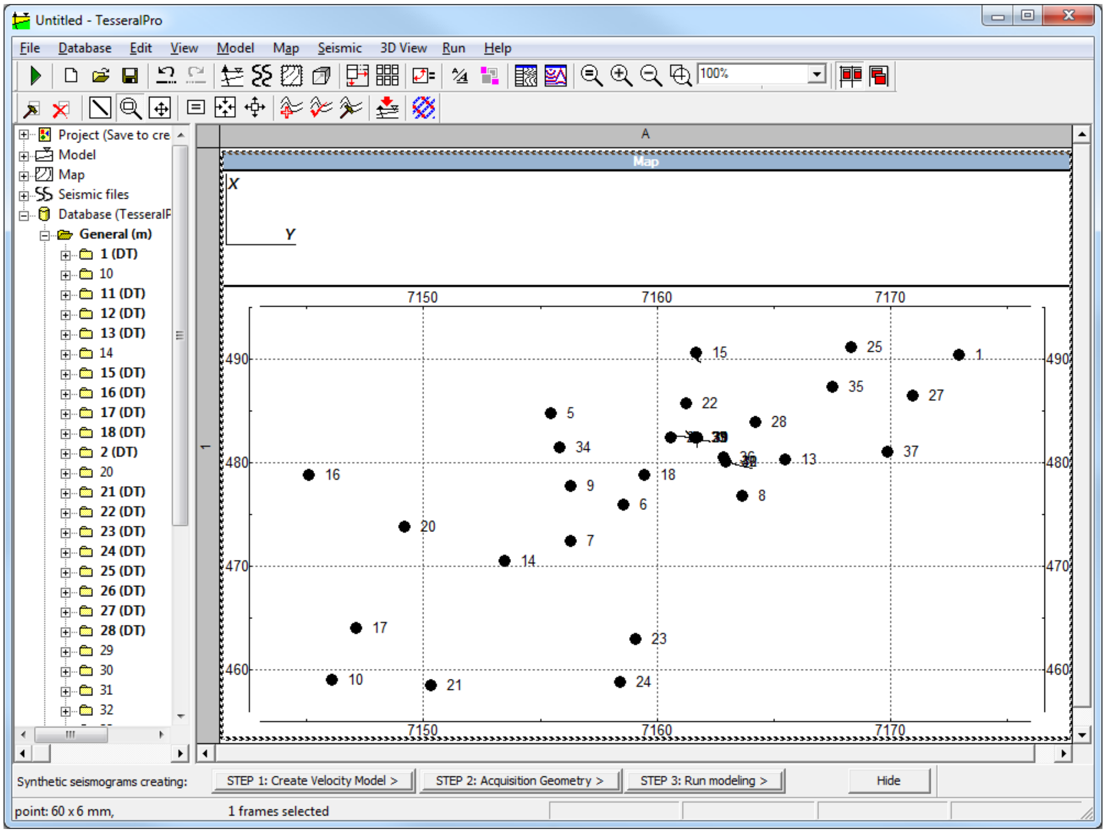
Work Area
X min 35
X max 3955
Y min 35
Y max 4515

Edit top title
Edit bottom title
Project Properties and Coordinate orientation...
Work area
Font...
Palette...
Isolines Properties
Color
Geometry
Background Picture
Load
OK
Cancel
OK
Cancel

The working area can also be selected visually by the mouse in the following modes: `Map > Zoom Mode` or `Map > Move Mode`. In both modes the selection (displacement) of the area is done by left-clicking the mouse on the `Map` Frame (press-drag-release).

> **NOTE:** If the area was selected incorrectly: (1) To cancel the last action, please use `Edit > Undo`; (2) To zoom the area, use the command `Map > Zoom Mode`, and then select the area again.

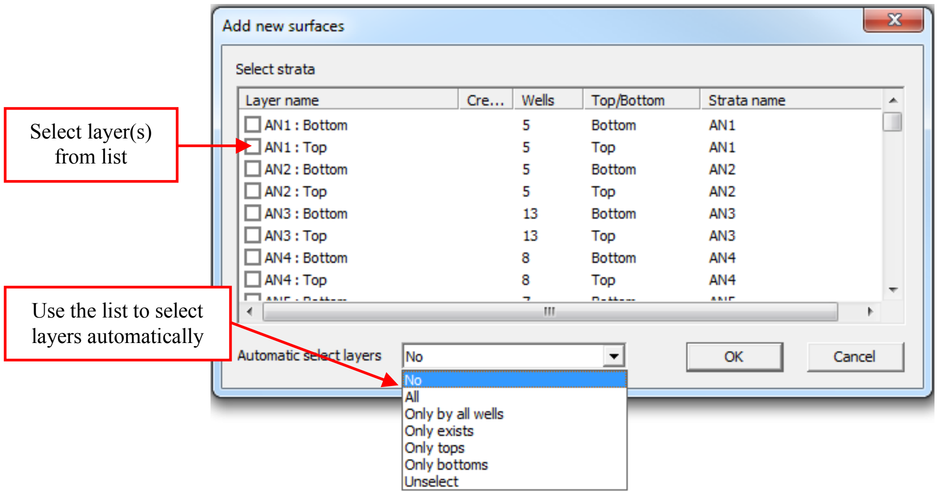
Please see the results


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Project (Save to cre
Model
Map
Seismic files
Database (TesseralP
General (m)
1 (DT)
10
11 (DT)
12 (DT)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
24 (DT)
25 (DT)
26 (DT)
27 (DT)
28 (DT)
29
30
31
32
A
Map
X
Y
7150
7160
7170
490
480
470
460
15
25
1
35
27
5
22
28
34
39
36
13
37
16
18
9
8
6
20
7
14
17
23
10
21
24
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 60 x 6 mm,
1 frames selected

14.2.4 Surface mapping

Surface mapping is based on the intersection data of well layers. Tesseral Pro supports 8 mapping methods, such as the spline-approximation and Kriging.

To create new surface maps, please use the `Map > Calculation of Horizon from Well Tops` menu command. In the `Add new surfaces` dialogue box please select the layers, for which you want to build the surface maps.


Add new surfaces
Select strata
OK
Cancel
No
All
Only by all wells
Only exists
Only tops
Only bottoms
Unselect

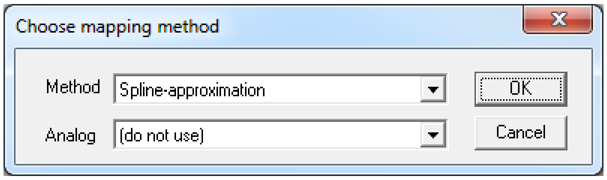
Select layer(s) from list

Use the list to select layers automatically

Layer name	Cre...	Wells	Top/Bottom	Strata name
☐ AN1 : Bottom		5	Bottom	AN1
☐ AN1 : Top		5	Top	AN1
☐ AN2 : Bottom		5	Bottom	AN2
☐ AN2 : Top		5	Top	AN2
☐ AN3 : Bottom		13	Bottom	AN3
☐ AN3 : Top		13	Top	AN3
☐ AN4 : Bottom		8	Bottom	AN4
☐ AN4 : Top		8	Top	AN4

Automatic select layers: No

Next, select one of the mapping methods available from the list.


Choose mapping method
OK
Cancel

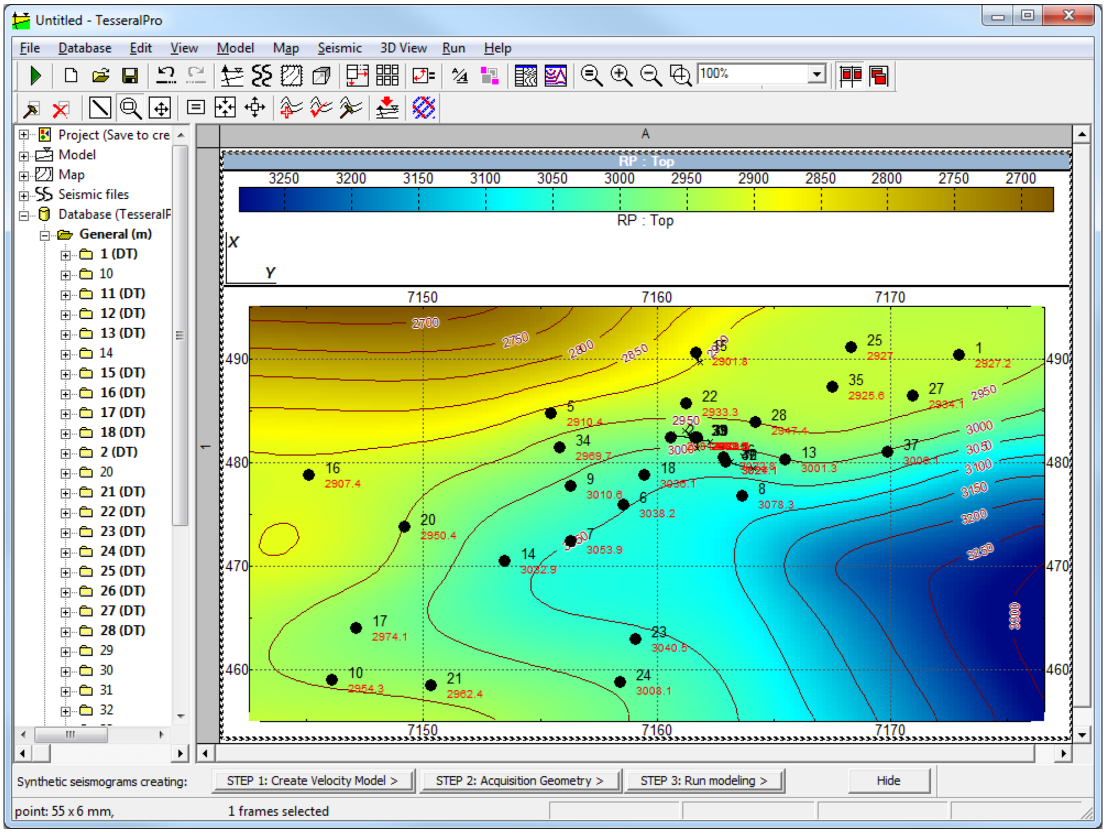
Method: Spline-approximation

Analog: (do not use)

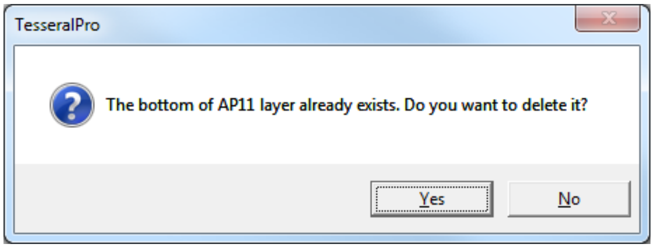
NOTE: Depending on the input data, the most suitable method is selected automatically from the list.

The surface calculation for the selected layers will be done automatically by the selected mapping method.

Please see the results


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Project (Save to cre
Model
Map
Seismic files
Database (TesseralP
General (m)
1 (DT)
10
11 (DT)
12 (DT)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
24 (DT)
25 (DT)
26 (DT)
27 (DT)
28 (DT)
29
30
31
32
A
RP : Top
3250 3200 3150 3100 3050 3000 2950 2900 2850 2800 2750 2700
RP : Top
X
Y
7150 7160 7170
490 480 470 460
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 55 x 6 mm,
1 frames selected

NOTE: If you want to re-build surfaces using another mapping method or to build other layer surfaces, please choose the command `Map > Add New Horizon from Well Tops` again. The program will propose you to delete the existing surface if you want to re-calculate it again.

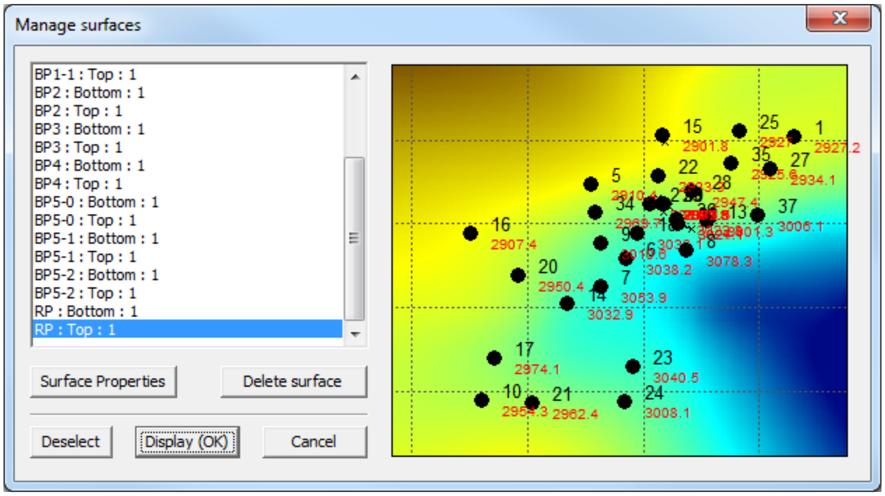

TesseralPro

The bottom of AP11 layer already exists. Do you want to delete it?

Yes
No

14.2.5 Handling surfaces

Please use the command `Map > Manage/Delete Surfaces` to delete and modify the properties (name, top and bottom) of any surface displayed in the `Map` Frame.

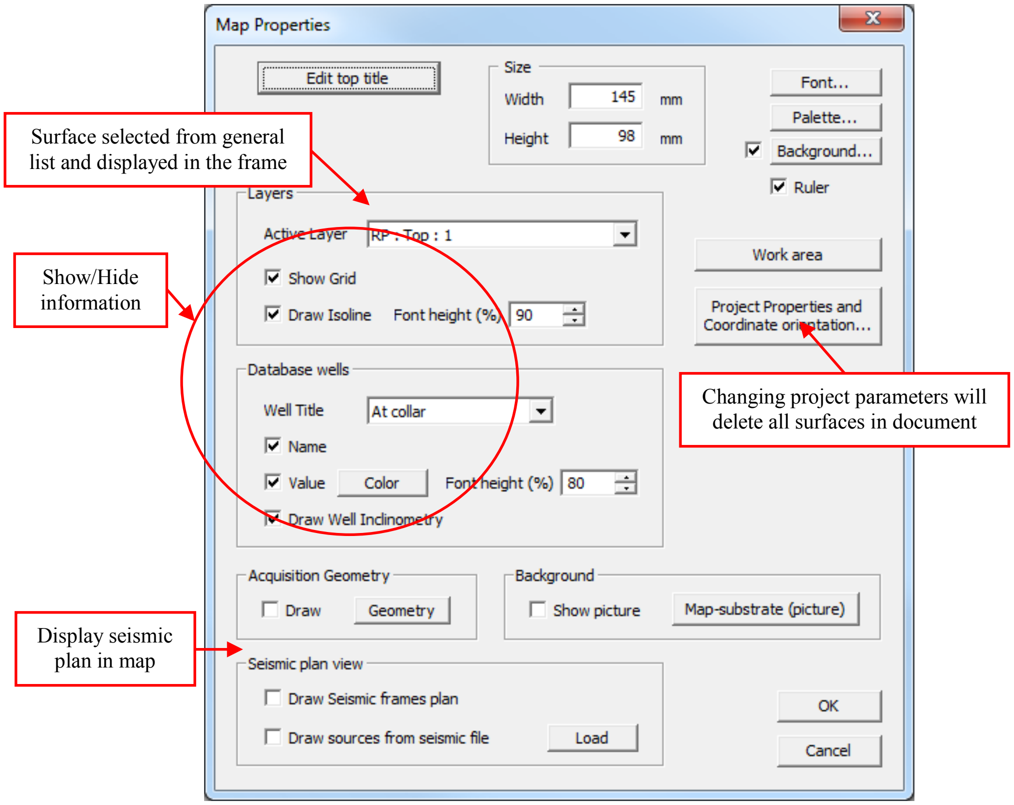

Manage surfaces
Surface Properties
Delete surface
Deselect
Display (OK)
Cancel
15
25
1
2901.8
2927.2
35
27
22
2934.1
5
28
34
13
37
3006.1
16
2907.4
20
2950.4
7
3078.3
3038.2
14
3053.9
3032.9
17
2974.1
23
3040.5
10
21
24
2962.4
3008.1

BP1-1 : Top : 1
BP2 : Bottom : 1
BP2 : Top : 1
BP3 : Bottom : 1
BP3 : Top : 1
BP4 : Bottom : 1
BP4 : Top : 1
BP5-0 : Bottom : 1
BP5-0 : Top : 1
BP5-1 : Bottom : 1
BP5-1 : Top : 1
BP5-2 : Bottom : 1
BP5-2 : Top : 1
RP : Bottom : 1
RP : Top : 1

NOTE: The `Undo`/`Redo` commands are not supported while handling surfaces (creating, loading, deleting).

14.2.6 Surface display

The display parameters for the Map Frame can be changed in the `Map Properties` dialogue box (the command `Edit > Edit Frame Properties` or `Map > Map Frame Properties`).



Map Properties

Edit top title

Size
Width 145 mm
Height 98 mm

Font...
Palette...
☑ Background...
☑ Ruler

Layers
Active Layer RP : Top : 1
☑ Show Grid
☑ Draw Isoline Font height (%) 90

Work area
Project Properties and Coordinate orientation...

Database wells
Well Title At collar
☑ Name
☑ Value Color Font height (%) 80
☑ Draw Well Inclinometry

Acquisition Geometry
☐ Draw Geometry

Background
☐ Show picture Map-substrate (picture)

Seismic plan view
☐ Draw Seismic frames plan
☐ Draw sources from seismic file Load

OK
Cancel

Surface selected from general list and displayed in the frame

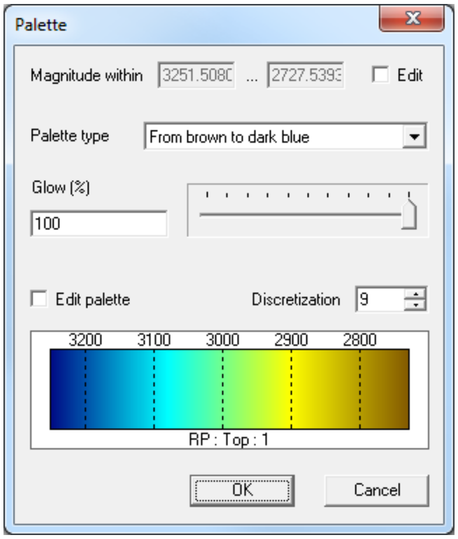
Show/Hide information

Display seismic plan in map

Changing project parameters will delete all surfaces in document

> **NOTE:** The Map Frame "does not contain" the loaded and calculated surfaces. All surfaces are saved into a common block in the Tesseral Pro document (`Map > Manage/Delete Surfaces`). The Map Frame is used to display any of the loaded (calculated) surfaces. It means that, in any Map Frame, you can show any surface from the common list. Deleting a surface from this list will lead to its "disappearing" from all Map Frames where this surface was shown. The commands `Map > Active Surface Processing` (rotation, displacement, and smoothing) can also change the surface data itself (not only its display in the Frame).

To change the palette of the surface, please select the Map Frame with the mouse and then use the command `Edit > Palette` or click the `Palette` button in the `Map Properties` dialogue box.



Palette

Magnitude within 3251.508 ... 2727.539 ☐ Edit

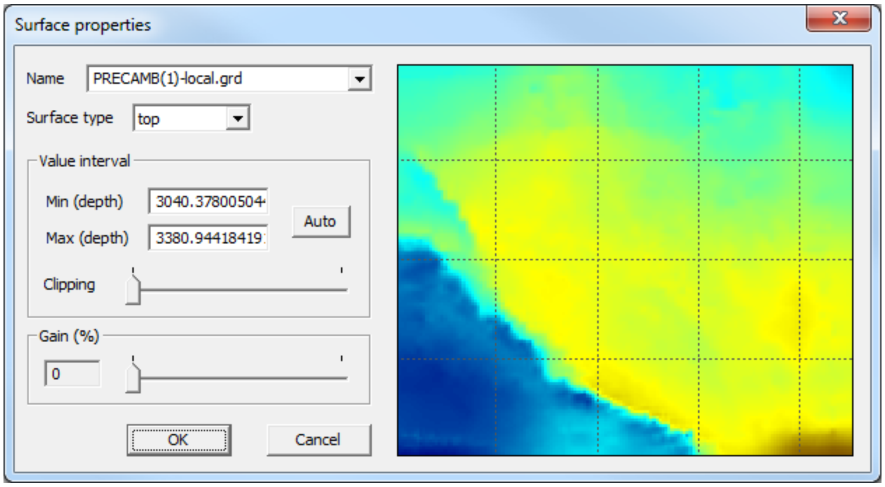
Palette type: From brown to dark blue

Glow (%): 100

☐ Edit palette

Discretization: 9

The displayed amplitude of the surface cannot be changed (scaled down) in the `Palette` dialogue box. But it can be changed by using the command `Map > Active Surface Processing > Properties`.



Surface properties

Name: PRECAMB(1)-local.grd

Surface type: top

Value interval

Min (depth): 3040.37800504

Max (depth): 3380.94418419

Gain (%): 0

Here, it is also possible to change the model's name and the surface type. To change the surface itself (not only its display), please use the commands `Scale`, `Smooth`, `Rotate` from the menu `Map > Active Surface Processing` and in this case the commands `Undo`/`Redo` are not applicable.

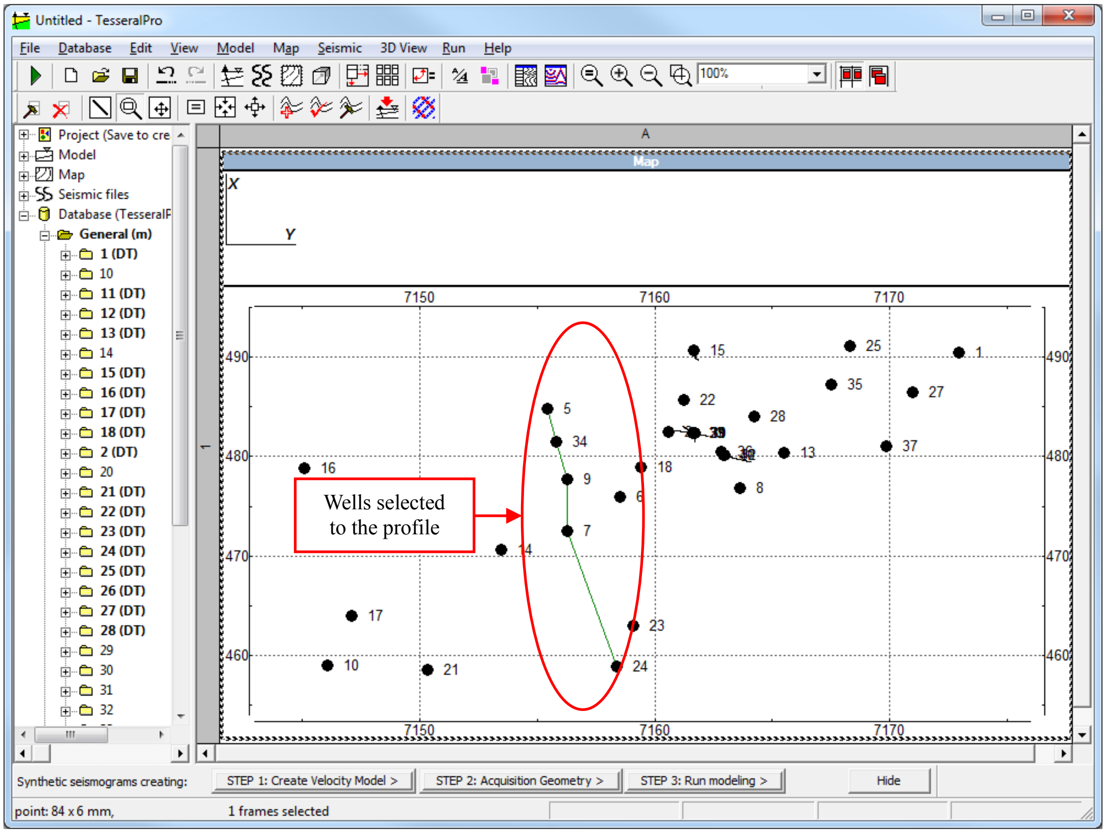
14.2.7 Build model from surfaces

Before building a model using surfaces, it is recommended to load or calculate these surfaces in Tesseral Pro. You do not need to have all surfaces ready before building the model. This process can be iterative, i.e., you can delete, add, re-calculate surfaces and re-build the existing model using the new surface data.

The steps to building a model from surfaces are as follows:

STEP 1. Select the wells for the section line (profile) – To select wells among those displayed in the Map Frame, please right-click the mouse button on the well you want to add to the profile. Then, in the context menu, select the command `Add Well to Profile`. The picture will not be changed after selecting the first well. Please repeat the process to add the other wells.

Please see the results



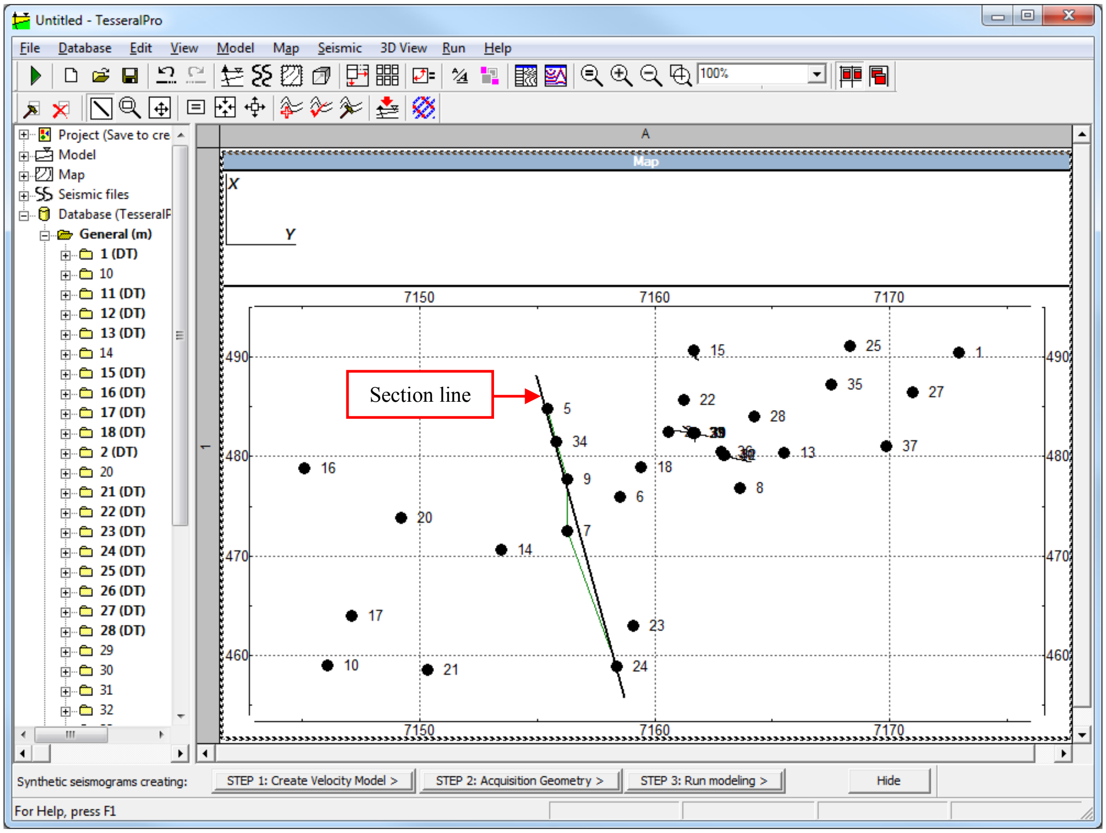
Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Project (Save to cre
Model
Map
Seismic files
Database (TesseralP
General (m)
1 (DT)
10
11 (DT)
12 (DT)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
24 (DT)
25 (DT)
26 (DT)
27 (DT)
28 (DT)
29
30
31
32
A
Map
X
Y
7150
7160
7170
490
480
470
460
15
25
1
35
27
5
22
28
34
39
37
16
18
30
13
9
6
8
7
14
17
23
10
21
24
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
point: 84 x 6 mm,
1 frames selected

Wells selected to the profile

To delete a well from the profile, please use the command `Delete Well from Profile` in the context menu or the `Map > Profile` menu. To clean the entire profile, use the command `Map > Profile > Empty Profile`.

STEP 2. Draw section line – Please select the mode `Map > Section Mode`. Then use the left mouse button to draw (press-drag-release) a section line.

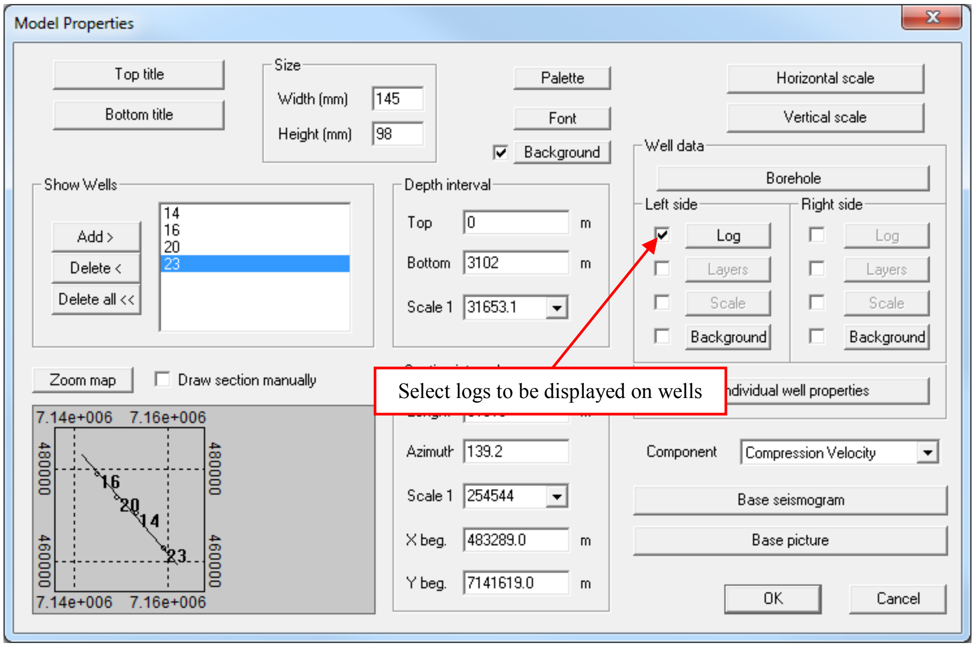
Please see the results


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
Project (Save to cre
Model
Map
Seismic files
Database (TesseralP
General (m)
1 (DT)
10
11 (DT)
12 (DT)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
24 (DT)
25 (DT)
26 (DT)
27 (DT)
28 (DT)
29
30
31
32
A
Map
X
Y
7150
7160
7170
490
480
470
460
Section line
15
25
1
35
27
22
28
5
34
39
13
37
16
18
9
6
8
20
7
14
17
23
10
21
24
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide
For Help, press F1

STEP 3. Create a model – Please use the command `Map > Transmit Horizons to Model` to launch the Wizard for creating a model. More detailed information can be found in the Section *4.4*.

STEP 4. Support of thin layering – If you would like to fill the polygon's parameters by the well log data, you need to load these log curves to the wells in the model via the dialogue box `Polygon Properties` (the command `Model > Edit Polygon`, after you select the polygon).

In the `Polygon Properties` dialogue box that opens, please select the acoustic log for automatic parameter setting `From Log` for the polygons created by surfaces. The remaining parameters of the Model Frame can be set right now or later via the dialogue box `Model > Model Frame Properties`. More details can be found in the Section *4.1*.


Model Properties
Top title
Bottom title
Palette
Font
Background
Horizontal scale
Vertical scale
Well data
Borehole
Left side
Right side
Log
Layers
Scale
Background
Individual well properties
Add >
Delete <
Delete all <<
Zoom map
Base seismogram
Base picture
OK
Cancel
7.14e+006 7.16e+006
480000
460000
16
20
14
23

Size
Width (mm) 145
Height (mm) 98

☑ Background

Show Wells: 14, 16, 20, 23

Depth interval
Top 0 m
Bottom 3102 m
Scale 1 31653.1

☐ Draw section manually

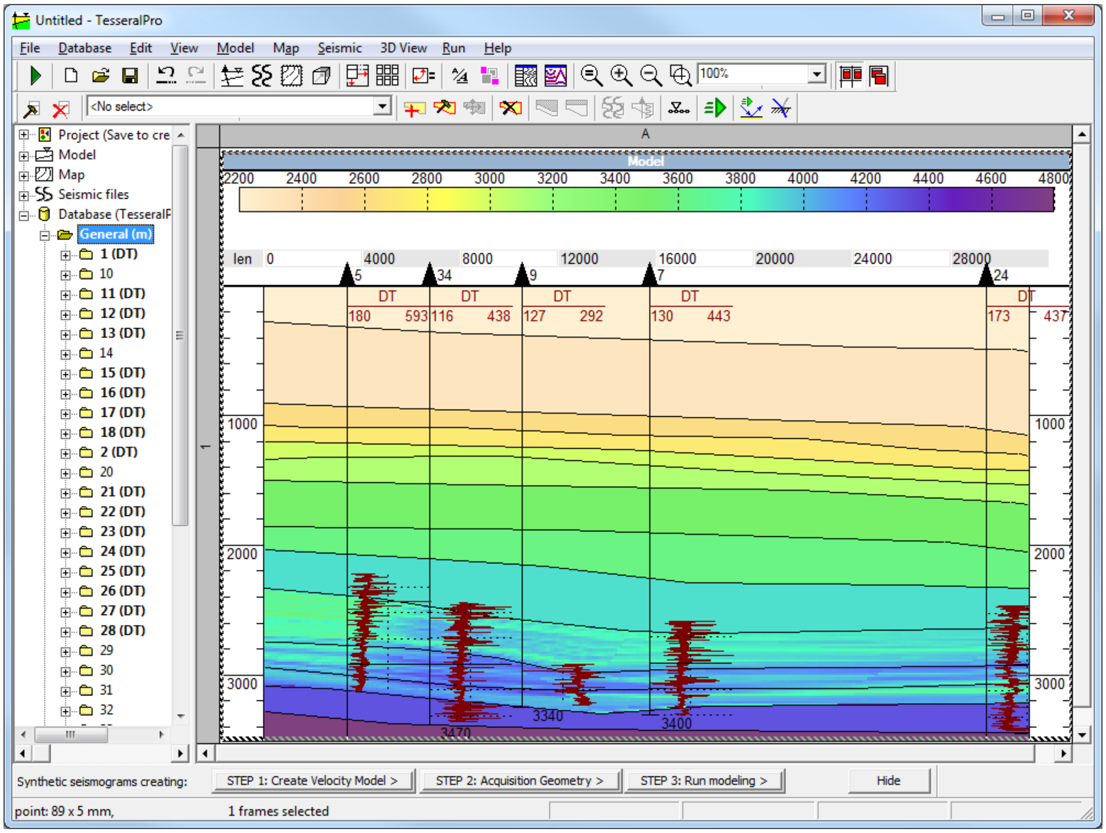
Azimuth 139.2
Scale 1 254544
X beg. 483289.0 m
Y beg. 7141619.0 m

Left side: ☑ Log ☐ Layers ☐ Scale ☐ Background
Right side: ☐ Log ☐ Layers ☐ Scale ☐ Background

Component Compression Velocity

Select logs to be displayed on wells

Please see the results


Untitled - TesseralPro
File Database Edit View Model Map Seismic 3D View Run Help
100%
<No select>
Project (Save to cre
Model
Map
Seismic files
Database (TesseralP
General (m)
1 (DT)
10
11 (DT)
12 (DT)
13 (DT)
14
15 (DT)
16 (DT)
17 (DT)
18 (DT)
2 (DT)
20
21 (DT)
22 (DT)
23 (DT)
24 (DT)
25 (DT)
26 (DT)
27 (DT)
28 (DT)
29
30
31
32
A
Model
2200 2400 2600 2800 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800
len 0 4000 8000 12000 16000 20000 24000 28000
5 34 9 7 24
DT DT DT DT DT
180 593 116 438 127 292 130 443 173 437
1000
2000
3000
3470 3340 3400
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

Synthetic seismograms creating:

point: 89 x 5 mm, 1 frames selected

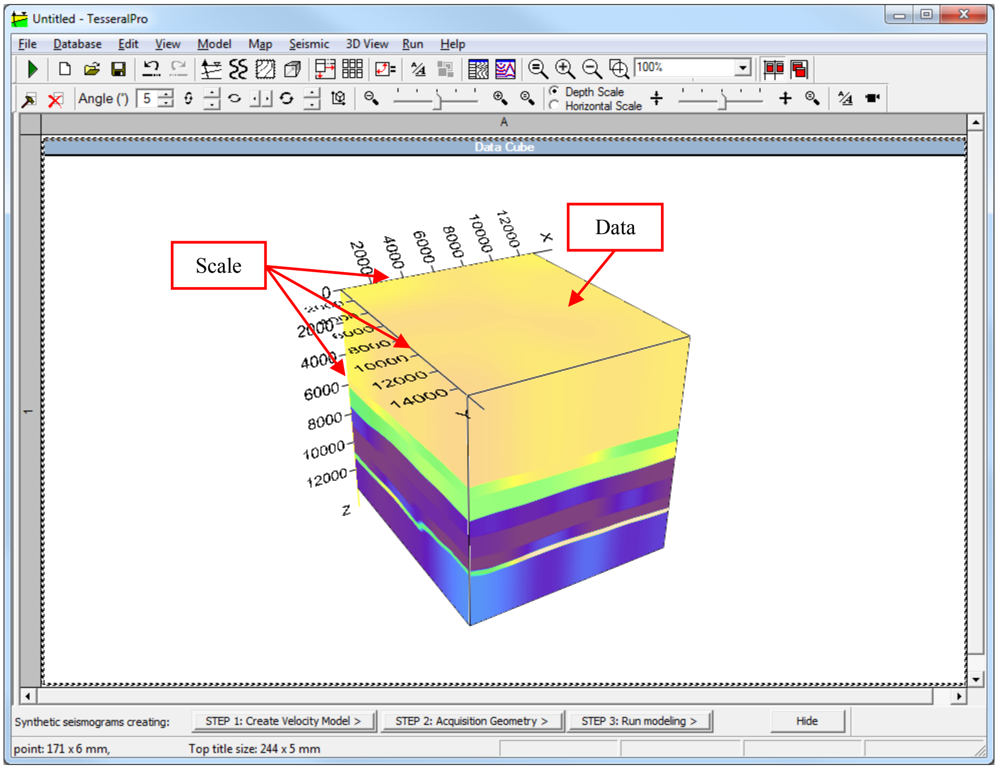
NOTE: Choosing the command `Map > Transmit Horizons to model` again when the `Model` Frame already exists will cause the model to be automatically re-built (1) from the selected section and profile in the map or (2) from the existing maps of the layer surfaces in the document.

STEP 5. Adjust model – More details can be found in the Section *4.11*.

NOTE: During the adjustment of the polygons' parameters that have been created automatically from the `Map` Frame, please use the `By default` button in the `Polygon Properties` dialogue box to memorize these parameters; they will be automatically filled next time you create polygons from the same layers.

15 3D View Frame

In Tesseral Pro, the `3D View` Frame is used for visualizing the spatial distribution of the data from a database, a project or from a user file. To rotate the data contained in this Frame, please use the toolbar buttons when this Frame is selected. The data are displayed in a cube. You can customize the scale of each edge of the cube by using `Object Properties`. Use the linear `Zoom` slider to zoom the display. For the axis, different scales may be adjusted (`Horizontal/Depth Scale`). To access object properties, please double-click on the object or use the command `3D View > Object Properties` (in the 2nd case, the object should have been selected in advance by the mouse). The data can be loaded into the cube using the `3D View` menu. All the data loaded to the cube are displayed together in a unified coordinate system. Let's describe the 3D View Frame in more details.

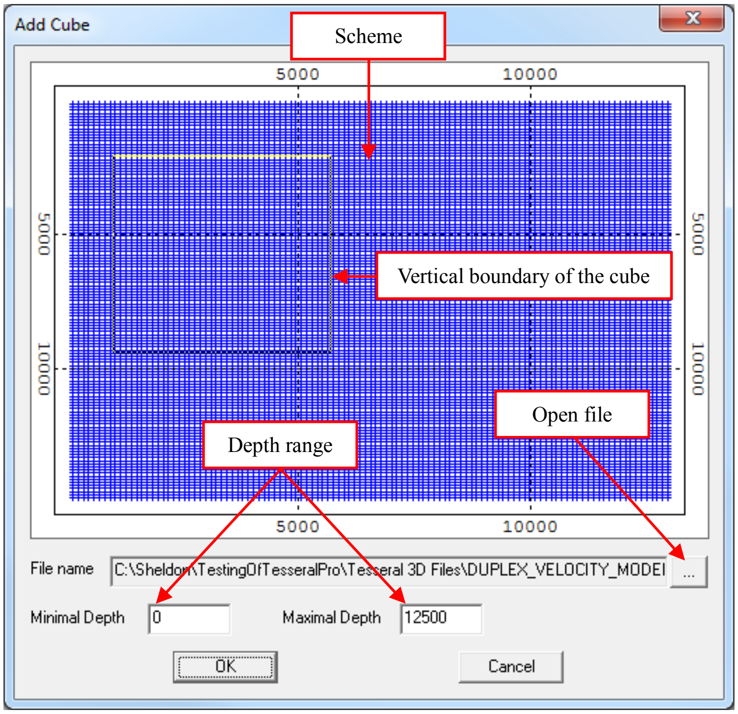

Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
Angle (°)
5
Depth Scale
Horizontal Scale
A
Data Cube
Scale
Data
2000
4000
6000
8000
10000
12000
X
0
2000
4000
6000
8000
10000
12000
14000
Y
Z
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

point: 171 x 6 mm, Top title size: 244 x 5 mm

15.1 Seismic Data Visualization

`The 3D View` frame allows displaying seismic data in the SEG-Y, SDS-PC and TGR formats. To load the cube, please use the command `3D View > Add Cube`. The `Add Cube` dialogue box will appear. Then, please load the target file. The receivers are shown as small blue crosses. Initially, the whole area is covered by the selected receivers. To select a rectangular part of the whole area, please draw the diagonal of the square you want to select while holding the left mouse button. Use the minimum/maximum depth parameter to limit the depth range of the cube. By default, the depth range is from the minimum to the maximum throughout the cube. After pressing `OK`, the `Cube Properties` dialogue box appears for users to specify the cube properties. The parameter step is the distance between the two neighboring nodes of the loaded grid along each of axis. This parameter can be increased to speed up drawing. The other parameters in this dialogue box are used to adjust the color palette. By default, the range of the palette is set from the minimum to maximum values obtained from the file. To set the range of the palette automatically for the displayed data, please select the `Auto fitting by cube values` option.

NOTE: Setting the "step" parameter too high decreases the drawing quality.



File name C:\Sheldon\TestingOfTesseralPro\Tesseral 3D Files\DUPLEX_VELOCITY_MODEI

Minimal Depth 0

Maximal Depth 12500

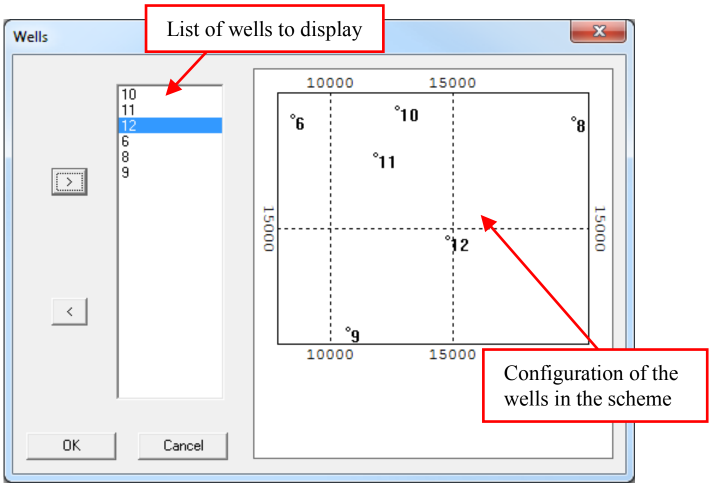
The procedure of loading profiles is practically the same as described above.

15.2 Surface Visualization

Surfaces are loaded from files in the same way. The command `3D View > Add Surface > From Project` is for loading surfaces from a Tesseral Pro project. After clicking `OK` in the `Add Surface From Project` dialogue box, the `Surface Properties` dialogue box will appear for each loaded surface. The palette can be defined either from the active surface or from any other surface (check the `Filling by another surface` option). The interval of the palette can be set by the user (`Set own interval`) or by the minimum and maximum values in the surface (`Auto fitting by surface values`) or by the minimum and maximum values in all surfaces in the Frame (`Set general depth interval`). Check the option `Apply to all` to apply the palette settings to all available surfaces.

15.3 Visualization of inclinometry logs, well logs and layers

To load wells from the database, please use the menu command `3D View > Add/Remove Wells`, then in the `Wells` dialogue box define the list of wells you would like to see in the Frame. To set well properties, use the command `3D View > Well Properties`.

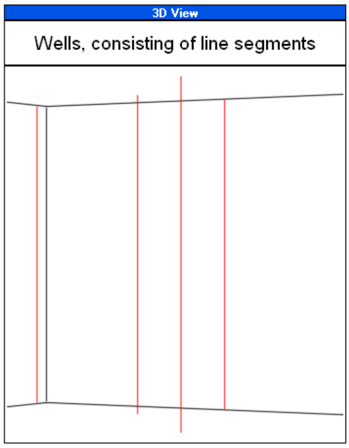

Wells
10
11
12
6
8
9
>
<
OK
Cancel
10000
15000
15000
15000
6
10
8
11
12
9
10000
15000

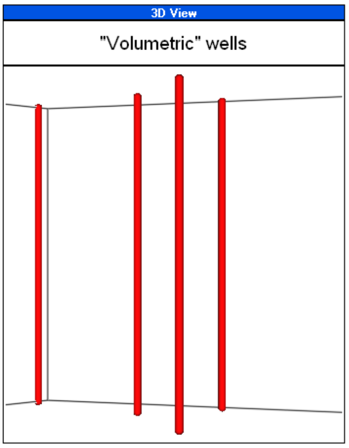
List of wells to display

Configuration of the wells in the scheme

15.3.1 “General” tab – General well properties

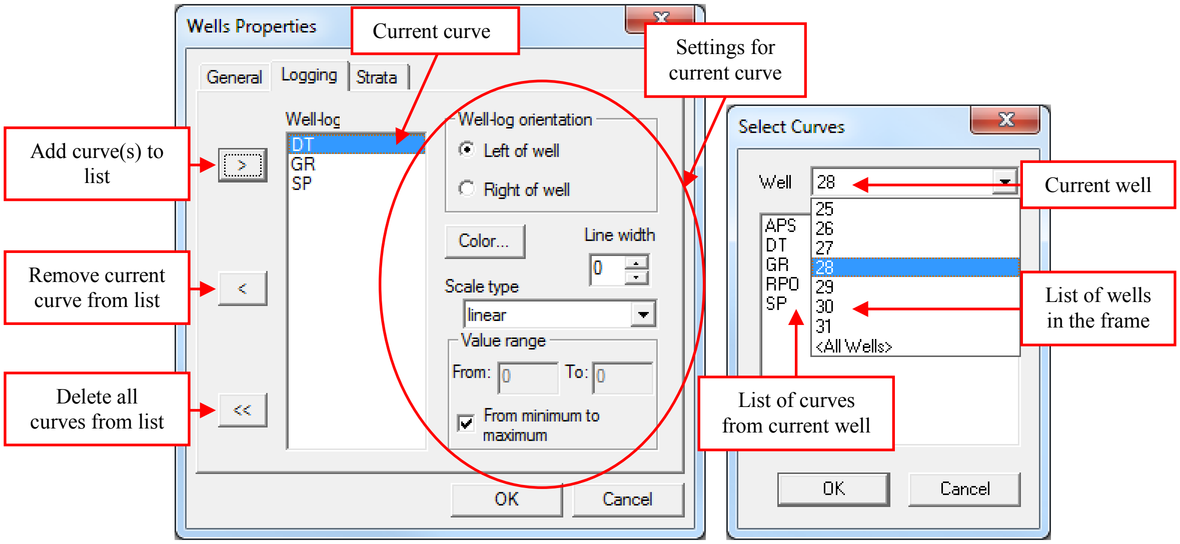
A well can be shown in form of a line or a 3D pipeline with a given radius (the `Fictive Radius` parameter) by checking the `Pipeline View` option. If the `Number of slices to form a pipe` parameter is increased, the image quality will be improved, however, this can affect the program performance. The `Length of a straight pipe section` parameter is not for displaying the inclinometry data saved in the database, but for selecting the values from the database, provided that the distance along the well between the two neighboring values is bigger than the given value of this parameter. This parameter affects performance of the program in the same way as the parameter `Number of slices to form a pipe`. You can limit the well in depth by using the parameters `Min` and `Max` after checking the `Depth range` option. The parameters `Width of well-log display region` and `Stratum marker: fictive radius` are used to adjust the display of the corresponding well logs and layers and are described below.





15.3.2 Well logs visualization

To add a well log into the Frame, please use the `Well Properties` dialogue box, and then go to the `Logging` tab. The `Well-log` list contains the names of the curves to be displayed in the Frame. All the options to the right of the list are for adjusting the active curve. The curves are added to the list by using the `Select Curves` dialogue box. Initially, the list in the `Select Curves` dialogue box contains all available curves from the wells in the Frame (if the Frame does not have any wells, the dialogue box will contains the list of all curves in the database). To obtain the list of the curves for one specific well, please select the required well from the list. The curve will be displayed in the Frame on the left or on the right of the well. The width of each curve can be edited in the `Well Properties` dialogue box. A value of 0 means that the curve will not be smoothed and it will have the minimum possible width. The curves with higher width values will be smoothed. The other settings for the curves are similar to the ones described in Section *5.10*. The width of the region for curve display can be adjusted in the "General" tab by setting the `Width of well-log display region` parameter.


Wells Properties
General
Logging
Strata
Well-log
DT
GR
SP
>
<
<<
Well-log orientation
● Left of well
○ Right of well
Color...
Line width
0
Scale type
linear
Value range
From:
0
To:
0
☑ From minimum to maximum
OK
Cancel
Select Curves
Well
28
APS
DT
GR
RPO
SP
25
26
27
28
29
30
31
<All Wells>
OK
Cancel

Current curve

Settings for current curve

Add curve(s) to list

Remove current curve from list

Delete all curves from list

Current well

List of wells in the frame

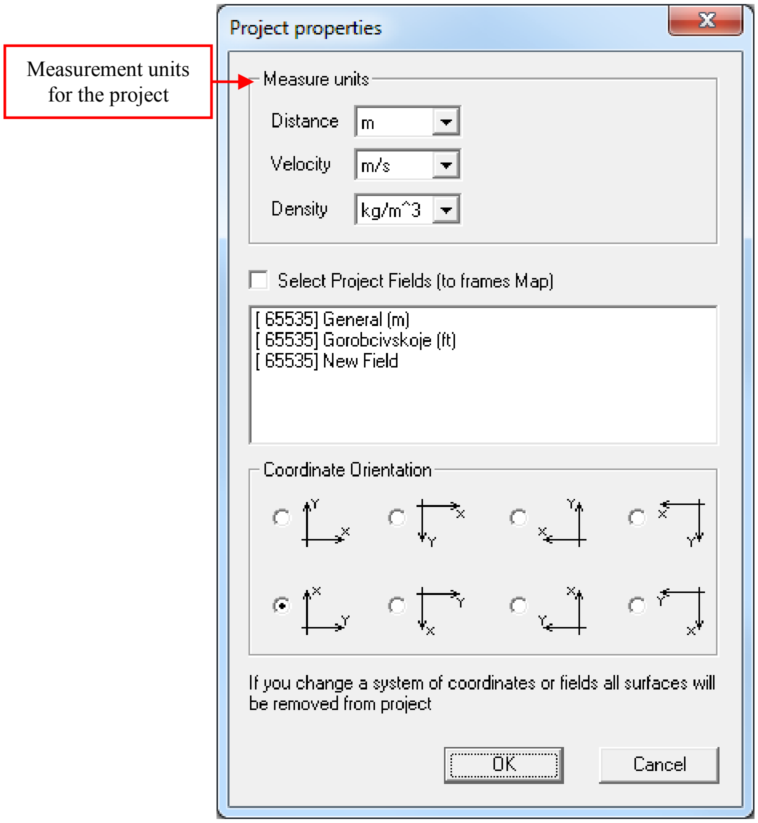
List of curves from current well

15.3.3 Layer Visualization

You can display special marks at the intersections of wells with the tops of layers. To do this, go to the `Strata` tab in the `Well Properties` dialogue box. The list on the left of the dialogue box shows available layers. The layers in the list on the right will be displayed in the Frame as circles on the wells. You can define the circles' width in the `General` tab by setting the `Stratum marker: fictive radius` parameter.

16 Annex 1: Measurement units

To select the measurement units, the command `File > Project Properties` is used.



Measurement units for the project

Project properties

Measure units

Distance: m

Velocity: m/s

Density: kg/m^3

☐ Select Project Fields (to frames Map)

[65535] General (m)
[65535] Gorobcivskoje (ft)
[65535] New Field

Coordinate Orientation

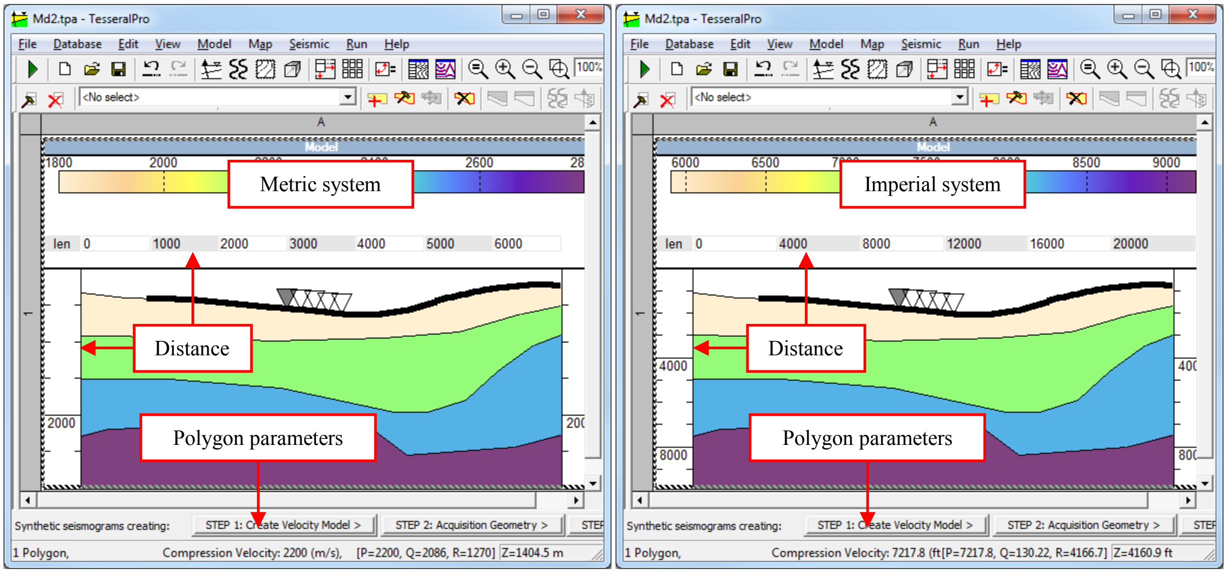
If you change a system of coordinates or fields all surfaces will be removed from project

Different data types and different frame types handle the measurement units selected in the project properties in a different way. For example, the database does not depend on the project, and each oil field (and even well) may have their own measurement units for depths and logging data depending on initially loaded data. Each gather could have been created in metric or imperial system, but it should correctly loaded into Tesseral Pro. Every kind of data can be "adjusted" to the chosen measurement units by using the appropriate settings and commands in Tesseral Pro.

The following section describes how to convert various input data into the measurement units you need.

16.1 Model Frame

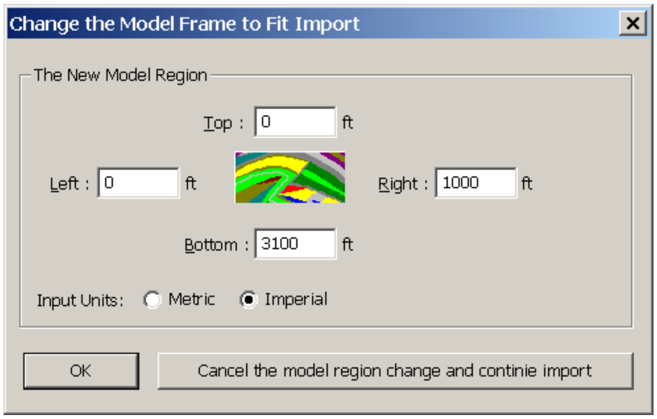
The `Velocity` and `Density` parameters determine the output units for velocity and density in the model polygons' properties. `Distance` represents the units for model's length/width, coordinate binding and acquisition geometry. If the measurement units are changed in the project, the `Distance` may be re-calculated. If parameters `Velocity` and `Density` are changed, the polygons' data display is also changed.


Md2.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
Metric system
Distance
Polygon parameters
Imperial system
Distance
Polygon parameters
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >

1 Polygon, Compression Velocity: 2200 (m/s), [P=2200, Q=2086, R=1270] Z=1404.5 m

1 Polygon, Compression Velocity: 7217.8 (ft[P=7217.8, Q=130.22, R=4166.7] Z=4160.9 ft

If the model is loaded from other formats (`File > Load Model`), for which the measurement units are unknown, users need to specify the measurement units (Metric or Imperial) in the dialogue box below.



Change the Model Frame to Fit Import

The New Model Region

Top : 0 ft

Left : 0 ft

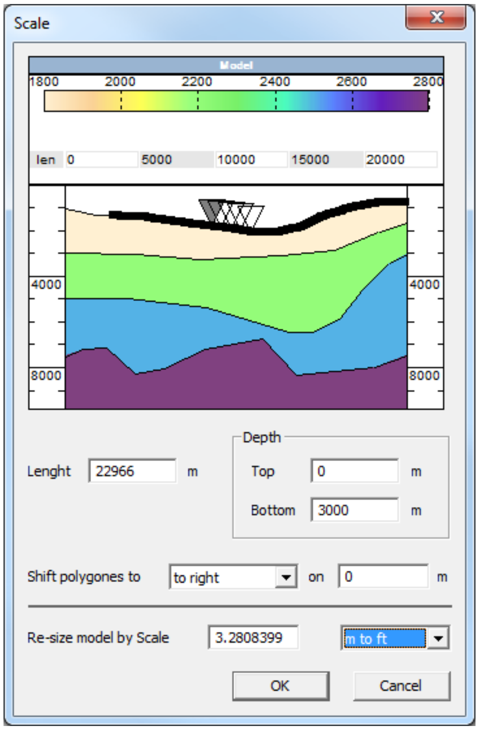
Right : 1000 ft

Bottom : 3100 ft

Input Units: ○ Metric ● Imperial

OK
Cancel the model region change and continie import

After that, the loaded model will be transformed into the project's measurement units (if the file's measurement unit differs from the project's one). Additionally, the Distance of the loaded model may be adjusted manually by the command `Model > Scale`. It is possible to select the scaling coefficient for the model, and transform the measurement units from ft to m or vice versa.


Scale
Model
1800
2000
2200
2400
2600
2800
len
0
5000
10000
15000
20000
4000
8000
4000
8000
OK
Cancel

Lenght 22966 m

Depth

Top 0 m

Bottom 3000 m

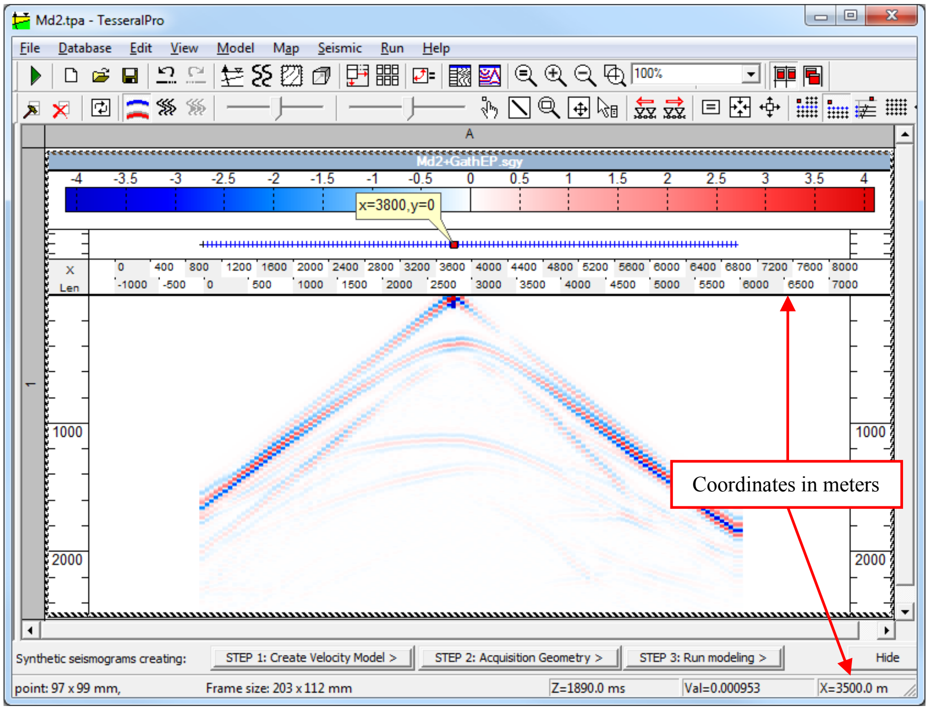
Shift polygones to to right on 0 m

Re-size model by Scale 3.2808399 m to ft

16.2 Seismic Frame

If the measurement units are changed in the project, only the display in the current project's Seismic Frame is updated: gathers' distance, velocity and density are shown in the chosen measurement units; however, the data files themselves are **not** modified.

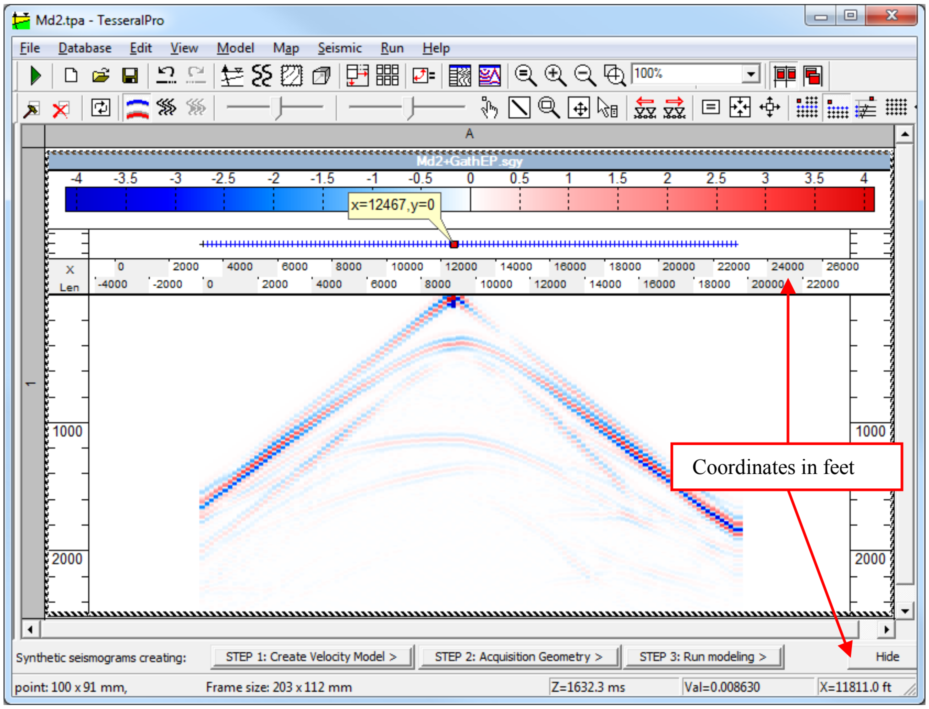
For example, if you have selected *ft* as distance units for the project, the display of trace coordinates will change accordingly. For instance, if the `Distance` option in the project is set to *meters*, a SEG-Y file is displayed as follows:


Md2.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
A
Md2+GathEP.sgy
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4
x=3800,y=0
X
Len
0 400 800 1200 1600 2000 2400 2800 3200 3600 4000 4400 4800 5200 5600 6000 6400 6800 7200 7600 8000
-1000 -500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000
1000
2000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

Coordinates in meters

point: 97 x 99 mm, Frame size: 203 x 112 mm Z=1890.0 ms Val=0.000953 X=3500.0 m

If the `Distance` option is set to *feet*, the same SEG-Y file is displayed as follows:

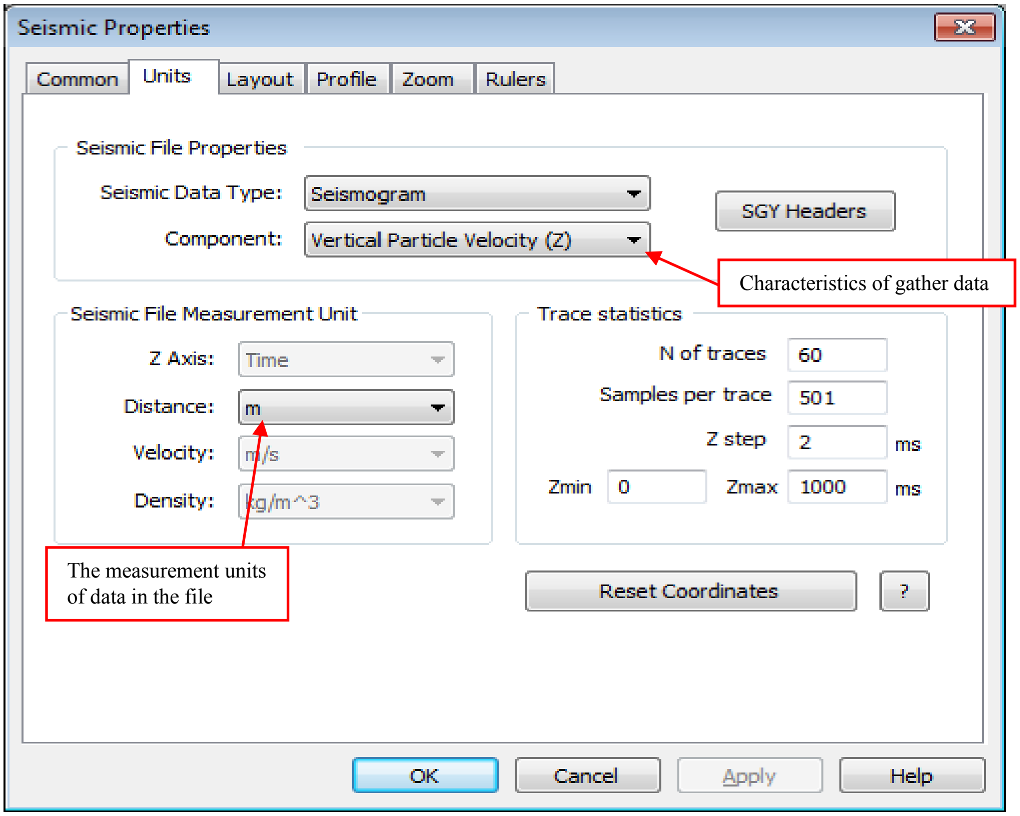

Md2.tpa - TesseralPro
File Database Edit View Model Map Seismic Run Help
100%
A
Md2+GathEP.sgy
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4
x=12467,y=0
X
Len
0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000 22000 24000 26000
-4000 -2000 0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000 22000
1000
2000
Synthetic seismograms creating:
STEP 1: Create Velocity Model >
STEP 2: Acquisition Geometry >
STEP 3: Run modeling >
Hide

Coordinates in feet

point: 100 x 91 mm, Frame size: 203 x 112 mm Z=1632.3 ms Val=0.008630 X=11811.0 ft

When the displayed data is in seismic formats TGR or SEG-Y, and the data is velocity or density, then their values will be scaled in accordance with the selected measurement units.

Please select the component of the seismic file to be displayed by specifying the `Component` parameter in the `Seismic File Properties` dialogue box which is invoked by `Seismic > Seismic Frame Properties`.


Seismic Properties
Common
Units
Layout
Profile
Zoom
Rulers
Seismic File Properties
SGY Headers
Seismic File Measurement Unit
Trace statistics
Reset Coordinates
?
OK
Cancel
Apply
Help

Seismic Data Type: Seismogram
Component: Vertical Particle Velocity (Z)

Characteristics of gather data

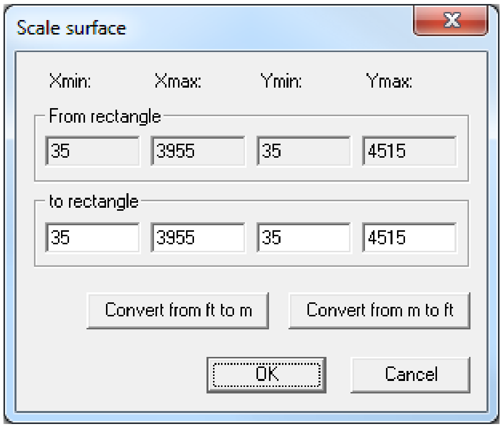
Z Axis: Time
Distance: m
Velocity: m/s
Density: kg/m^3

The measurement units of data in the file

N of traces 60
Samples per trace 501
Z step 2 ms
Zmin 0 Zmax 1000 ms

16.3 Map Frame

If the project's measurement units are changed, the loaded and computed surfaces will be deleted. To transform the size of the loaded surface from *m* to *ft* or vice versa, use the command `Map > Active Surface Processing > Scale Boundaries`.



	Xmin:	Xmax:	Ymin:	Ymax:
From rectangle	35	3955	35	4515
to rectangle	35	3955	35	4515

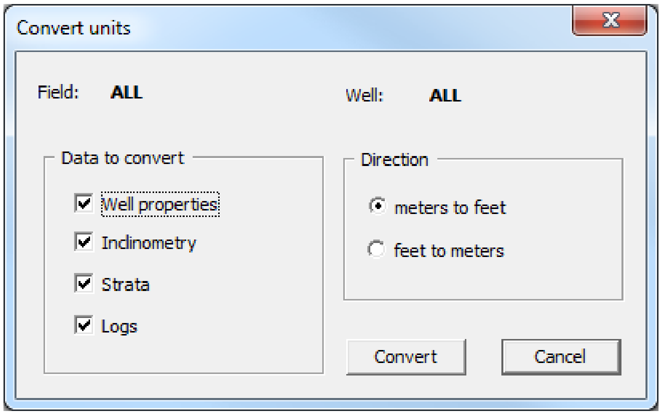
In the dialogue box above, please press `Convert from ft to m` or `Convert from m to ft` to convert the measurement units for the selected surface.

To convert the surfaces built by a database of well intersections, it is possible to change the distance measurement units in the database (oil field or well), and then build the surface again.

16.4 Database: transform the measurement units

Please see Section *17* for details about content and filling of the database.

The contents in the database do not depend on the selected measurement units in the project. Furthermore, some data in the database (for example, a particular field) may contain data in the imperial measurement system and other data may be in the metric one. To transform the data for such field from one measurement system to another, please select the field with mouse in the database tree, and then choose the command `Database > Convert Units`.



Convert units

Field: **ALL**   Well: **ALL**

Data to convert

☑ Well properties
☑ Inclinometry
☑ Strata
☑ Logs

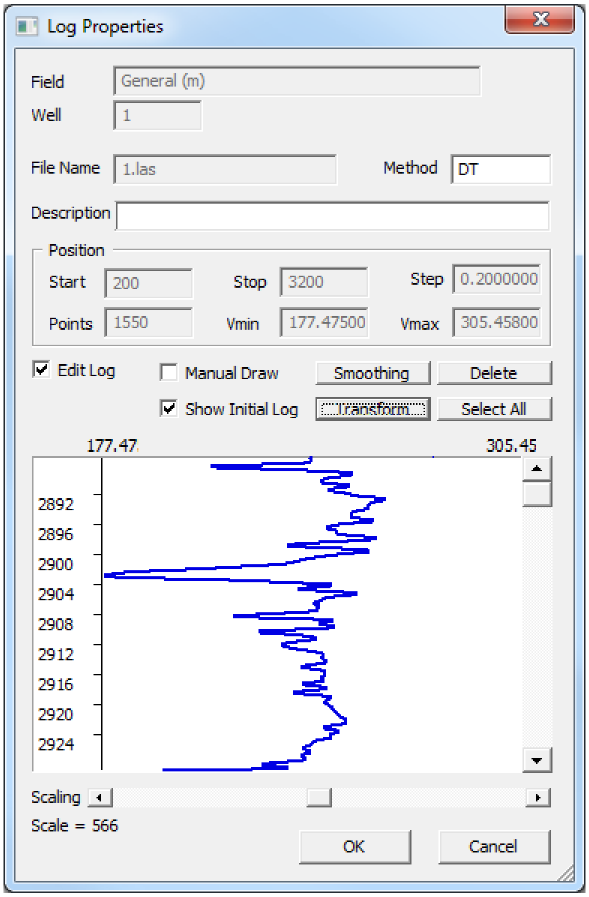
Direction

● meters to feet
○ feet to meters

In the dialogue box above, select the data you would like to convert and conversion direction (from *ft* to *m* or from *m* to *ft*).

> **NOTE**: Before well data is used for model building, the data must be converted to the project's measurement units (the command `Database > Convert Units`).

The values of curves loaded to the database may also be converted, but it has to be done one by one. To do this, please select the needed curve in the database tree, and choose the command `Database > Data Properties`.


Log Properties

Field: General (m)
Well: 1
File Name: 1.las
Method: DT
Description:

Position
Start: 200
Stop: 3200
Step: 0.2000000
Points: 1550
Vmin: 177.47500
Vmax: 305.45800

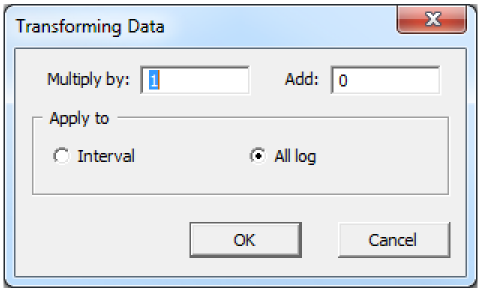
☑ Edit Log
☐ Manual Draw
☑ Show Initial Log

Smoothing
Delete
Transform
Select All
177.47
305.45
2892
2896
2900
2904
2908
2912
2916
2920
2924
Scaling

Scale = 566

OK
Cancel

In the `Log Properties` dialogue box, check `Edit Log` and press `Transform`. In the next dialogue box `Transforming Data` enter the scaling coefficient.


Transforming Data

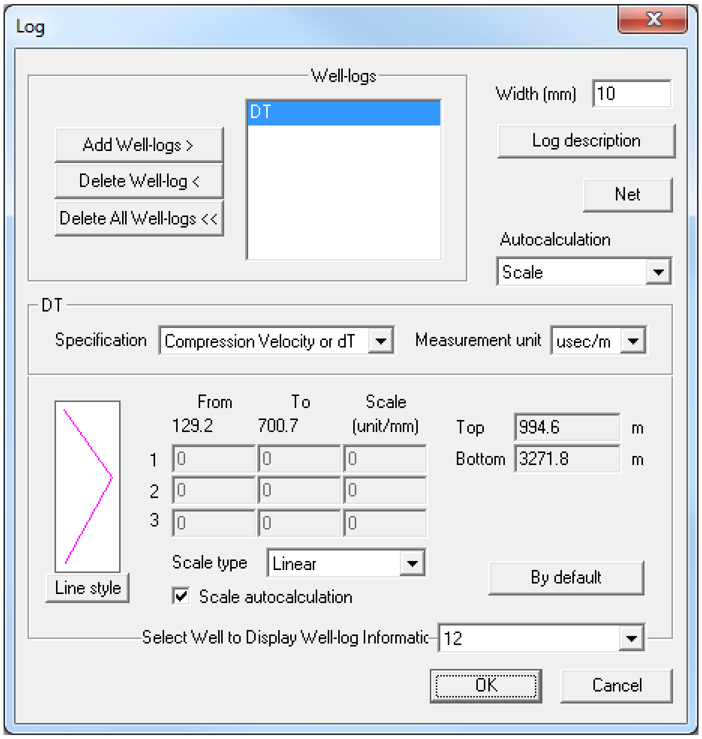
Multiply by: 1
Add: 0

Apply to
○ Interval
● All log

OK
Cancel

It is recommended to perform such data transformation for all the acoustic logs in all wells of the same deposits, so that the same measurement units are used.

After having normalized the logging data, it is possible to choose the measurement units for all curves of the model during model creation by well data, by specifying the `Measurement unit` parameter in the `Log` dialogue box.



Log
Well-logs
Add Well-logs >
Delete Well-log <
Delete All Well-logs <<
Log description
Net
Line style
By default
OK
Cancel

Well-logs: DT

Width (mm) 10

Autocalculation: Scale

DT

Specification: Compression Velocity or dT

Measurement unit: usec/m

	From	To	Scale (unit/mm)
	129.2	700.7	
1	0	0	0
2	0	0	0
3	0	0	0

Top 994.6 m

Bottom 3271.8 m

Scale type: Linear

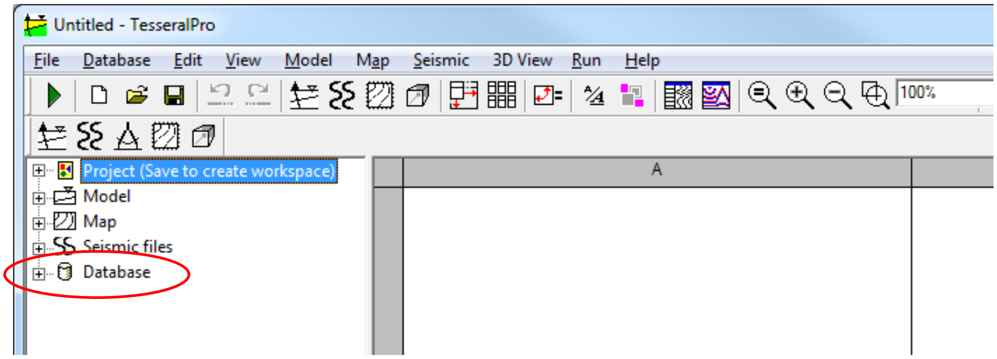
☑ Scale autocalculation

Select Well to Display Well-log Informatic: 12

While the polygon's parameters are filled with interpolated well data, the logging data are first converted to the selected measurement units of the project (m/s, ft/s, kg/m^3, g/cm^3). To ensure correct conversion of the measurement units, the measurement units for logging must be correctly set in the `Measurement unit` parameter.

17 Annex 2: Geophysical database

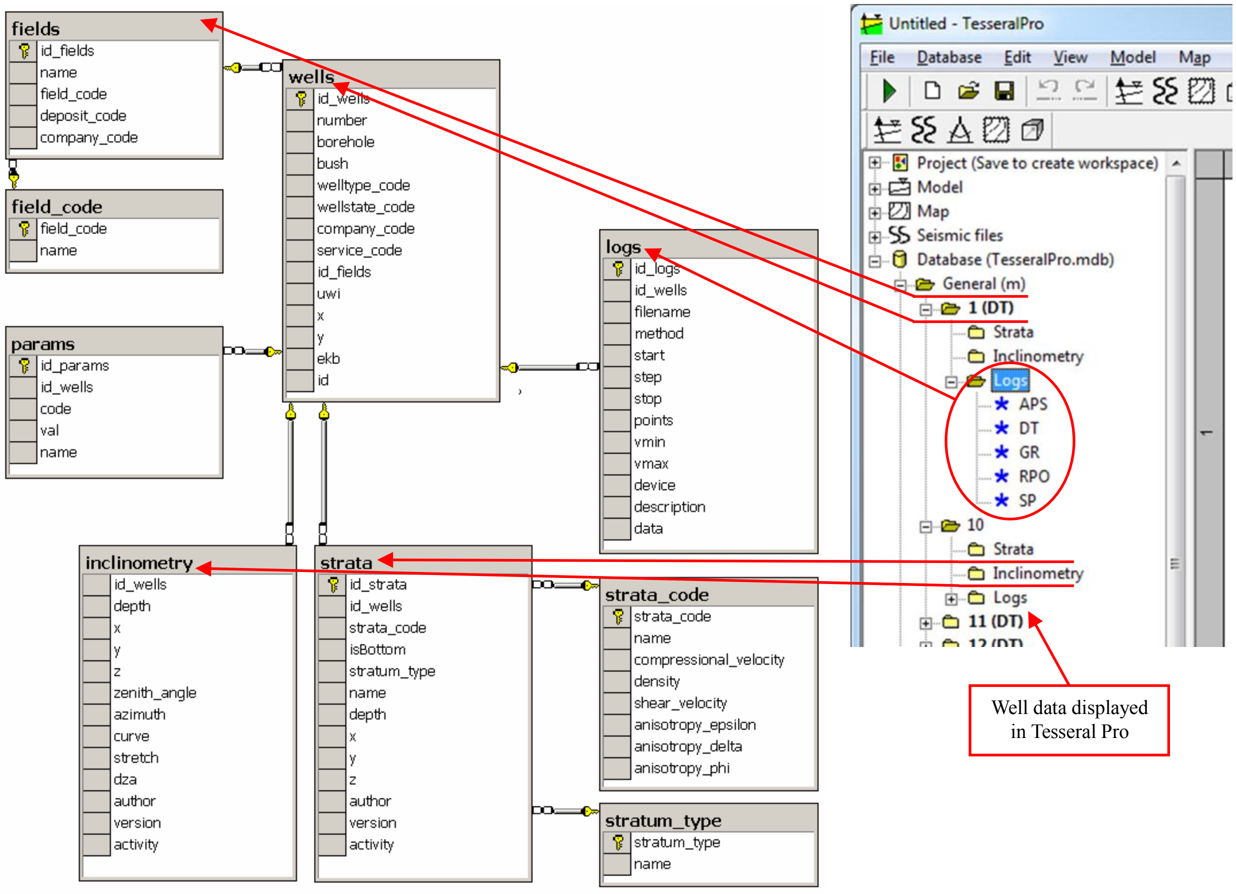
To connect to the database, expand the upper node of the `Database` tree in the left pane of the Tesseral Pro window.


Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Seismic
3D View
Run
Help
100%
Project (Save to create workspace)
Model
Map
Seismic files
Database
A

17.1 DBMS

Tesseral Pro uses DBMS MS SQL Server or MS Access to store well log data.

17.2 Diagram of Classes


fields
id_fields
name
field_code
deposit_code
company_code
field_code
field_code
name
params
id_params
id_wells
code
val
name
wells
id_wells
number
borehole
bush
welltype_code
wellstate_code
company_code
service_code
id_fields
uwi
x
y
ekb
id
logs
id_logs
id_wells
filename
method
start
step
stop
points
vmin
vmax
device
description
data
inclinometry
id_wells
depth
x
y
z
zenith_angle
azimuth
curve
stretch
dza
author
version
activity
strata
id_strata
id_wells
strata_code
isBottom
stratum_type
name
depth
x
y
z
author
version
activity
strata_code
strata_code
name
compressional_velocity
density
shear_velocity
anisotropy_epsilon
anisotropy_delta
anisotropy_phi
stratum_type
stratum_type
name
Untitled - TesseralPro
File
Database
Edit
View
Model
Map
Project (Save to create workspace)
Model
Map
Seismic files
Database (TesseralPro.mdb)
General (m)
1 (DT)
Strata
Inclinometry
Logs
APS
DT
GR
RPO
SP
10
Strata
Inclinometry
Logs
11 (DT)
12 (DT)

Well data displayed in Tesseral Pro

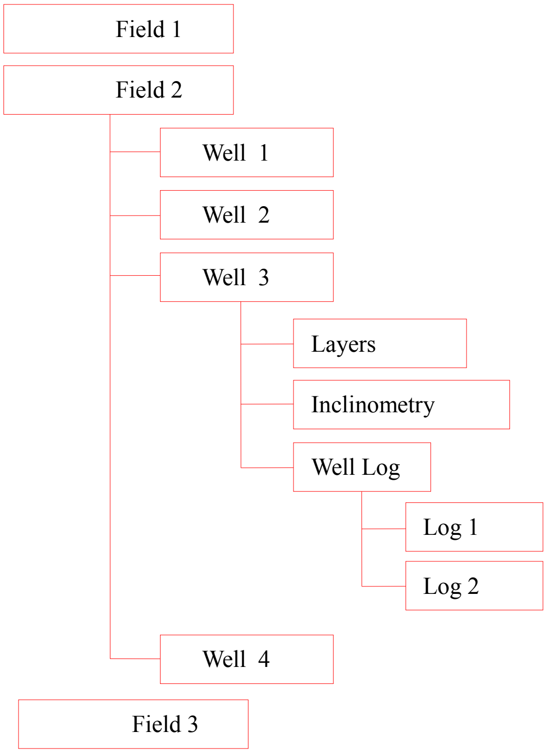
17.3 Description of tables and basic fields

Tesseral Pro has the following well log data structure:

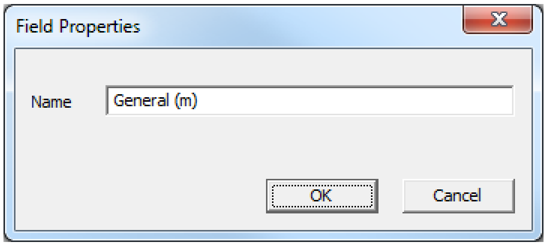
The upper level is Fields (`Fields` table). The database can contain several fields. The fields contain wells (`Wells` table). Each well may only belong to a single field.

A well can contain:

- Stratigraphy (`Strata` table) with stratigraphic well cutoffs.
- Well inclinometry (`Inclinometry` table).
- Well logs (`Logs` table)


Field 1
Field 2
Well 1
Well 2
Well 3
Layers
Inclinometry
Well Log
Log 1
Log 2
Well 4
Field 3

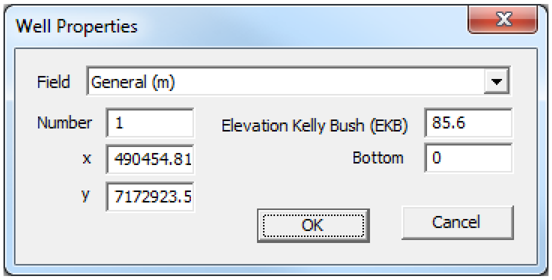
`Fields`: The main attribute is `Name` (name of the fields).


Field Properties
OK
Cancel

Name: General (m)

`Wells`: Belongs to a field. The main attributes are:

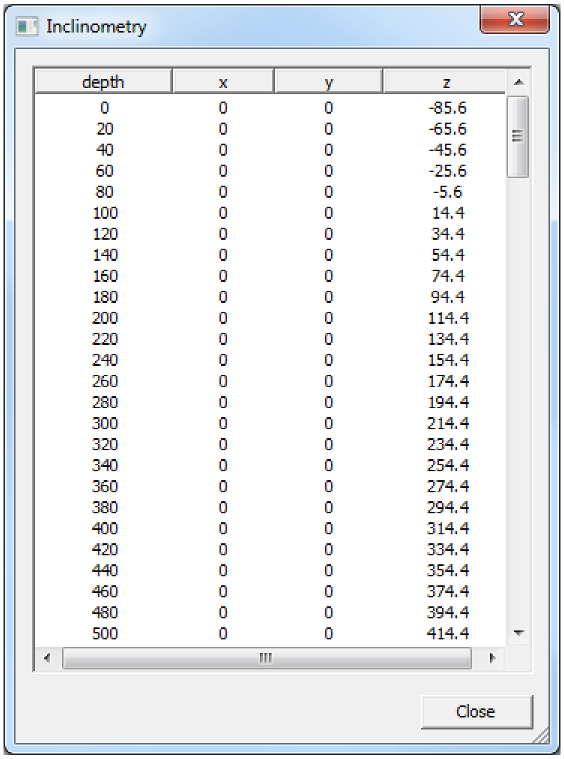
- `Number` – Well number (name)
- `x`, `y` – Well coordinates
- `EBK` – Elevation Kelly Bush (corresponds to the `Elevation Kelly Bush` parameter in the `Well Properties` dialogue box)
- `Borehole` – Well bottom (corresponds to the `Bottom` parameter in the `Well Properties` dialogue box)


Well Properties
OK
Cancel

Field: General (m)
Number: 1
x: 490454.81
y: 7172923.5
Elevation Kelly Bush (EKB): 85.6
Bottom: 0

`Inclinometry`: Belongs to the well. It contains the table with coordinates of the marks along the borehole.

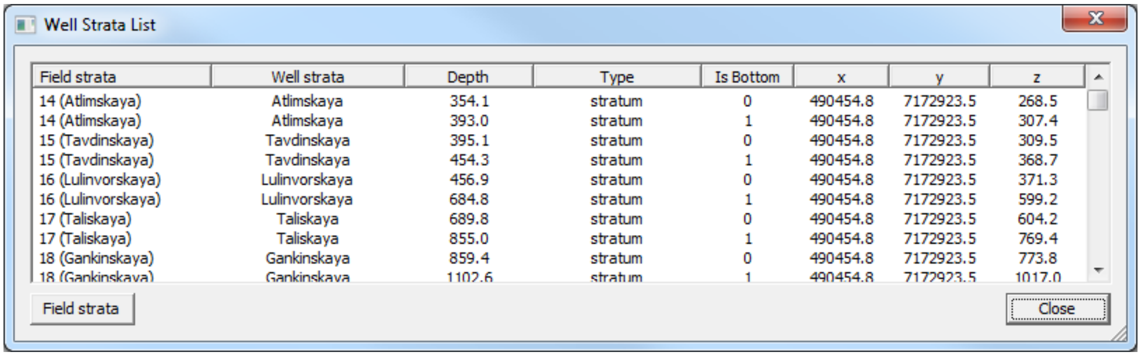
- `Depth` – Depth mark from the wellhead
- `x`, `y` – Borehole deviation from the wellhead at the current depth mark
- `z` – Absolute depth of the current well mark from the sea level; positive values mean 'below the sea level', negative otherwise



depth	x	y	z
0	0	0	-85.6
20	0	0	-65.6
40	0	0	-45.6
60	0	0	-25.6
80	0	0	-5.6
100	0	0	14.4
120	0	0	34.4
140	0	0	54.4
160	0	0	74.4
180	0	0	94.4
200	0	0	114.4
220	0	0	134.4
240	0	0	154.4
260	0	0	174.4
280	0	0	194.4
300	0	0	214.4
320	0	0	234.4
340	0	0	254.4
360	0	0	274.4
380	0	0	294.4
400	0	0	314.4
420	0	0	334.4
440	0	0	354.4
460	0	0	374.4
480	0	0	394.4
500	0	0	414.4

`Strata`: Belongs to the well. It contains the table of the well's layer-intersections. The main attributes are:

- `Well strata` is the name of layers
- `Type` defines the stratigraphic type (layer/mass/suite/stage and etc) of the current layer. The table of allowed database's stratigraphic types is `strata type`
- `Strata code` is the layer code in the database's code table `strata code`. It is used for automatic building of surfaces by using the layer-intersections
- `Depth` is the depth of layer intersection
- `x`, `y`, `z` are the absolute coordinates of the layer intersection
- `Is Bottom` –'1' for bottom, '0' for top



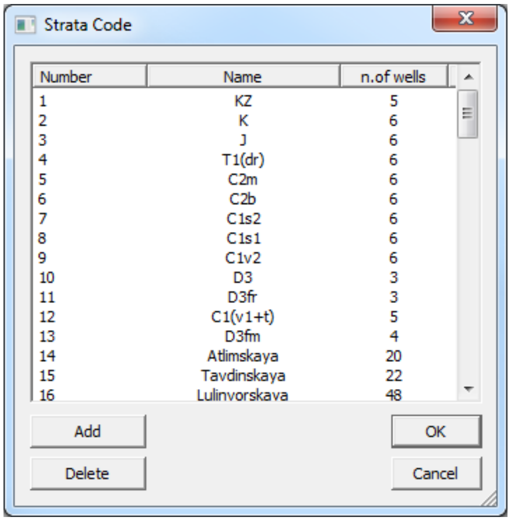
Field strata	Well strata	Depth	Type	Is Bottom	x	y	z
14 (Atlimskaya)	Atlimskaya	354.1	stratum	0	490454.8	7172923.5	268.5
14 (Atlimskaya)	Atlimskaya	393.0	stratum	1	490454.8	7172923.5	307.4
15 (Tavdinskaya)	Tavdinskaya	395.1	stratum	0	490454.8	7172923.5	309.5
15 (Tavdinskaya)	Tavdinskaya	454.3	stratum	1	490454.8	7172923.5	368.7
16 (Lulinvorskaya)	Lulinvorskaya	456.9	stratum	0	490454.8	7172923.5	371.3
16 (Lulinvorskaya)	Lulinvorskaya	684.8	stratum	1	490454.8	7172923.5	599.2
17 (Taliskaya)	Taliskaya	689.8	stratum	0	490454.8	7172923.5	604.2
17 (Taliskaya)	Taliskaya	855.0	stratum	1	490454.8	7172923.5	769.4
18 (Gankinskaya)	Gankinskaya	859.4	stratum	0	490454.8	7172923.5	773.8
18 (Gankinskaya)	Gankinskaya	1102.6	stratum	1	490454.8	7172923.5	1017.0

`Strata Code`: Belongs to the layers (stratigraphy). It contains the table with the codes of field layers.

The main attributes are:

- `Number` is the layer code in the database's code table `strata code`
- `Name` is the name of the layer code

- `n.of wells` is the number of wells, where a layer with the specific code is used


Strata Code
Add
Delete
OK
Cancel

Number	Name	n.of wells
1	KZ	5
2	K	6
3	J	6
4	T1(dr)	6
5	C2m	6
6	C2b	6
7	C1s2	6
8	C1s1	6
9	C1v2	6
10	D3	3
11	D3fr	3
12	C1(v1+t)	5
13	D3fm	4
14	Atlimskaya	20
15	Tavdinskaya	22
16	Lulinvorskaya	48

`Strata type`: Belongs to the layers (stratigraphy). It contains the table of layer types.

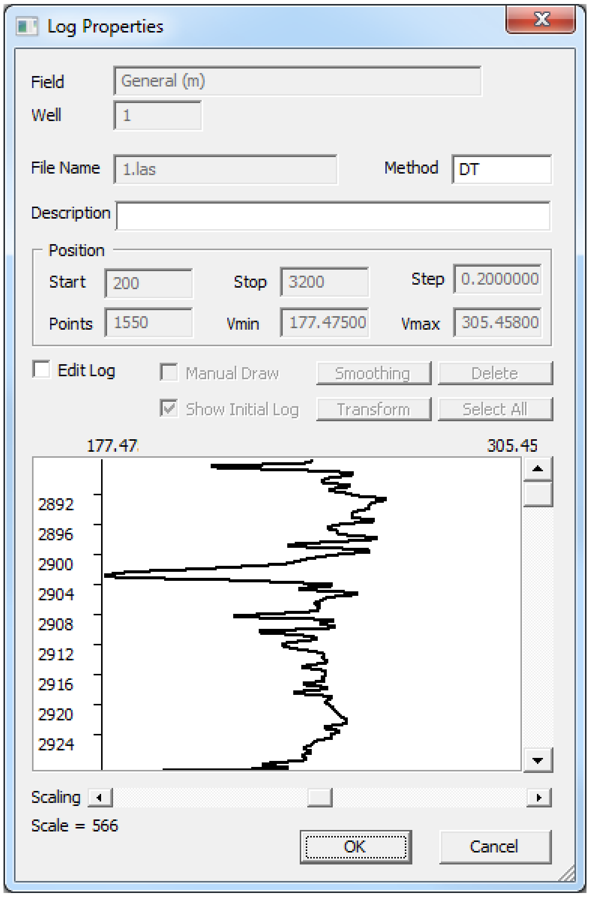
The main attributes are:

- `stratum type` is the layer's code in the layers codes table of the database `strata code`:
- `name` – is the layer name

`Logs` (log curves): Belongs to the well. It contains the table of the well logs.

The main attributes are:

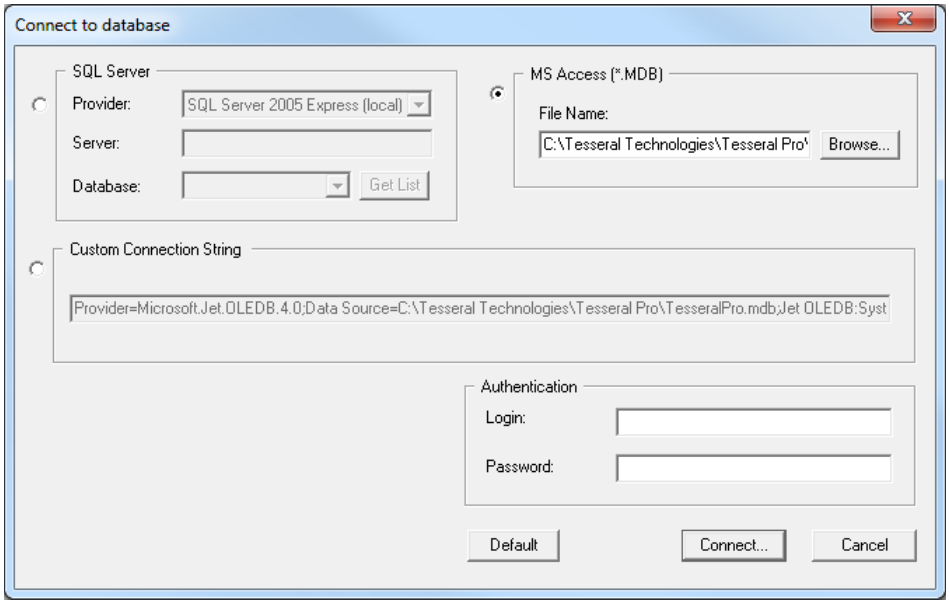
- `Method` is the layer's name
- `Start`, `Stop` are the curve's top and bottom
- `Step` is the curve's sampling step
- `Vmin`, `Vmax` are the curve's amplitude range


Log Properties
Smoothing
Delete
Transform
Select All
177.47
305.45
2892
2896
2900
2904
2908
2912
2916
2920
2924
Scaling
OK
Cancel

Field: General (m)
Well: 1
File Name: 1.las
Method: DT
Description:
Position
Start: 200
Stop: 3200
Step: 0.2000000
Points: 1550
Vmin: 177.47500
Vmax: 305.45800
☐ Edit Log
☐ Manual Draw
☑ Show Initial Log
Scale = 566

17.4 Database connection, creation and copying

Connection to the database is established automatically while loading Tesseral Pro or by using the command `Database > Connect`.


Connect to database
SQL Server
Server:
Database:
Get List
MS Access (*.MDB)
Browse...
Custom Connection String
Authentication
Login:
Password:
Default
Connect...
Cancel

○ SQL Server — Provider: SQL Server 2005 Express (local)

● MS Access (*.MDB) — File Name: C:\Tesseral Technologies\Tesseral Pro\

○ Custom Connection String: Provider=Microsoft.Jet.OLEDB.4.0;Data Source=C:\Tesseral Technologies\Tesseral Pro\TesseralPro.mdb;Jet OLEDB:Syst

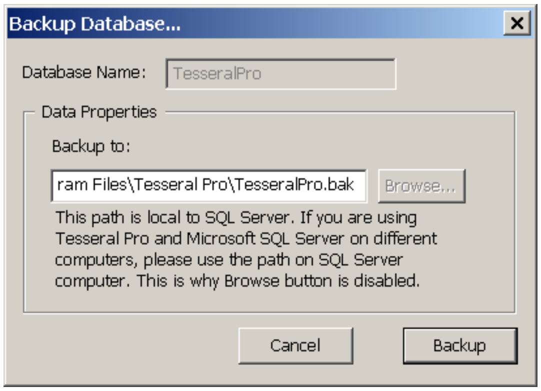
Please select the DBMS you would like to connect to, and adjust the connection parameters. The MS Access test database TesseralPro.mdb with several wells is included in the installation.

To back up the Database, please use the command `Database > Backup`.

For MS Access:

It creates a copy of the ".mdb" file by using the standard `Save As` dialogue box.

For MS SQL Server:


Backup Database...
Data Properties
Browse...
Cancel
Backup

Database Name: TesseralPro

Backup to: ram Files\Tesseral Pro\TesseralPro.bak

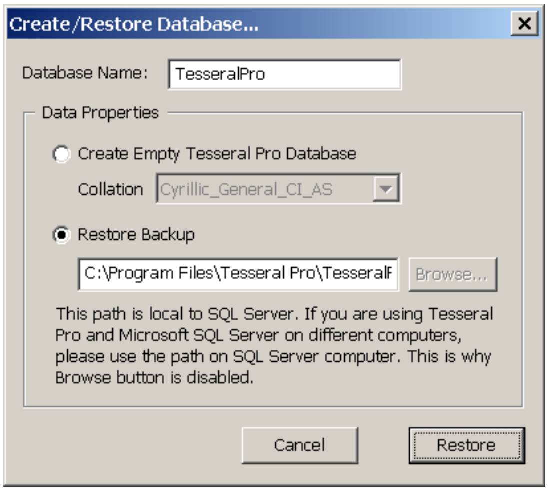
This path is local to SQL Server. If you are using Tesseral Pro and Microsoft SQL Server on different computers, please use the path on SQL Server computer. This is why Browse button is disabled.

Please provide the full path and name for the backup copy. It is recommended to back up the database before operations that could lead to data loss like loading and deletion, so that, in case of any incorrect actions, the database can be recovered from the backup copy.

To create or restore a Database, please use the command `Database > Create/Restore`.

MS Access creates a new ".mdb" file while creating a new database by using the standard `Save As` dialogue box. Restoring such Database is not supported, so please use the command `Database > Connect` to connect to another ".mdb" database.

When MS SQL Server creates a new database, please enter the `Database Name`, and then select `Create Empty Tesseral Pro Database`. To restore a database from the backup copy, please select `Restore Backup`, and then define the full file path and the name of the backup created previously.



Database Name: TesseralPro

○ Create Empty Tesseral Pro Database

Collation: Cyrillic_General_CI_AS

● Restore Backup

C:\Program Files\Tesseral Pro\TesseralF

This path is local to SQL Server. If you are using Tesseral Pro and Microsoft SQL Server on different computers, please use the path on SQL Server computer. This is why Browse button is disabled.

NOTE: All current data will be lost while restoring the database from a backup copy

17.5 Data loading

The data is loaded into Tesseral Pro either from LAS files (to the `Logs` table) or from text files to the tables `Wells`, `Inclinometry`, `Strata` and `Strata code`. Data can either be loaded to an existing well, or loaded to a field, in which case the program "distributes" the data from the file over the existing wells or creates new wells automatically.

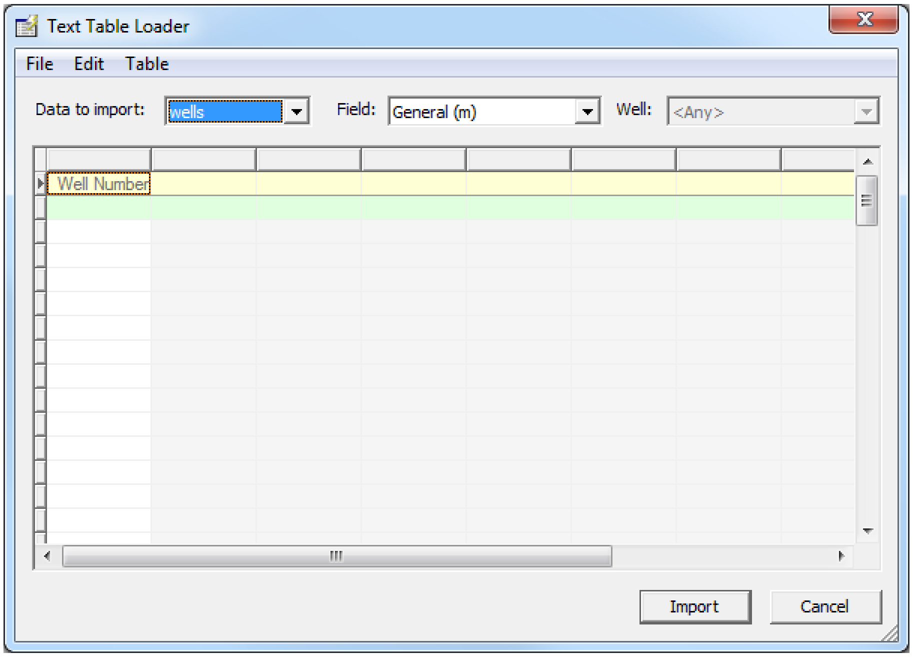
Data in text files (TXT, CSV, and TAB) must be presented in the form of columns (the columns are separated by spaces, tabs or semicolons). It is preferable that each column has its own header. For example,

Well Number	x	y	ekb	borehole
1	490454.8	7172923.5	85.6	3502
2	482493.0	7160560.5	96.4	3812
5	484796.1	7155446.5	89.7	3555
6	475956.6	7158533.5	100.0	3456
7	472471.0	7156297.5	100.4	2544
8	476867.3	7163649.5	91	3514
9	477733.9	7156292.5	98.2	3098
10	459056.6	7146075.5	92	3113
11	496123.6	717966674.9	11	3221
12	498422.6	718709668.9	12	2801
13	480333.9	7165486.5	87.7	4121
14	470601.8	7153447.5	105.6	3434

The first column is the obligatory well number where the data is to be loaded. To prepare data for loading, please use the command `Database > Prepare Text Tables`. To load prepared text files or files in LAS format, please use the command `Database > Import Data`.

STEP 1. Create a field – Please use the command `Database > Add Field`, and then set the name of the new field in the pop-up dialogue box

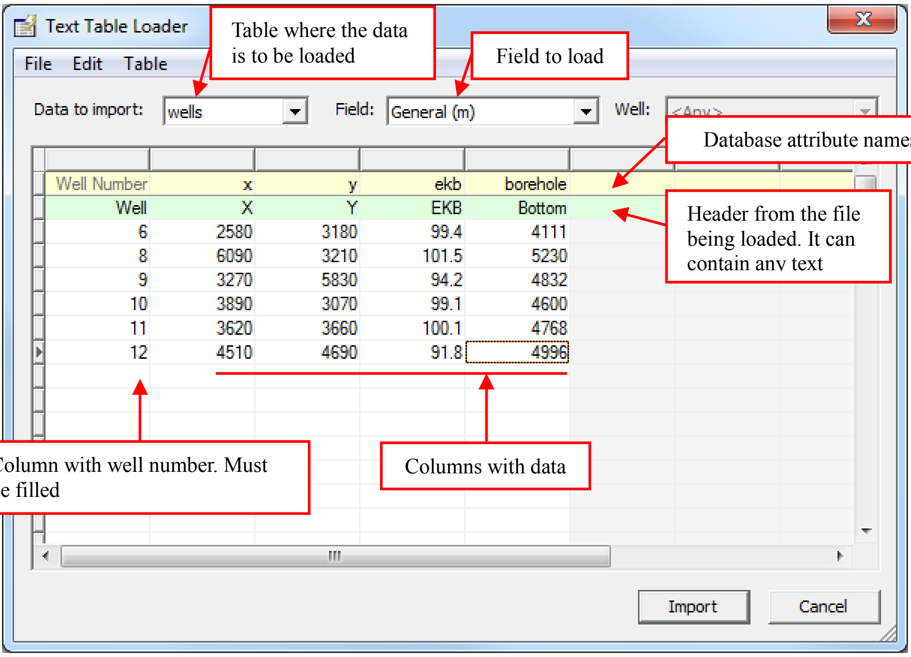
STEP 2. Load well coordinates, elevations and well bottoms – Please use the mouse button to select the field into which you would like to load the data, and then choose the command `Database > Prepare Text Tables`



Data to import: wells
Field: General (m)
Well: <Any>

In the `Data to import` list, please select `wells`.

If you have a text table with the necessary information, please use the command `File > Open` in the `Text Table Loader` dialogue box. If the data are in Microsoft Excel or Word format, use the `Copy/Paste` commands to transfer the data from the MS Office document to `Text Table Loader` via the Clipboard.



Data to import: wells

Field: General (m)

Well: <Any>

Well Number	x	y	ekb	borehole
Well	X	Y	EKB	Bottom
6	2580	3180	99.4	4111
8	6090	3210	101.5	5230
9	3270	5830	94.2	4832
10	3890	3070	99.1	4600
11	3620	3660	100.1	4768
12	4510	4690	91.8	4996

Table where the data is to be loaded

Field to load

Database attribute names

Header from the file being loaded. It can contain any text

Column with well number. Must be filled

Columns with data

The first column from the text table is obligatory and contains the number of wells into which the data is to be loaded. The light green (second) row is optional and it is intended for the headers from the input file. In the first yellow row, all the attribute names of the columns you want to load should be entered. Click the mouse inside each of the cells to select the attribute, into which the data from the column are to be loaded.

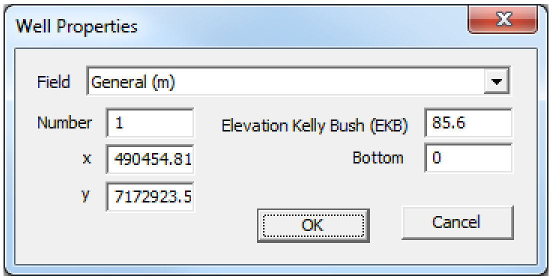
It is not necessary to load coordinates, bottom of the hole, and altitude all in one table; sequential data loading (amending) to the wells from several files is supported.

Please use the command `File > Save as text` in the `Text Table Loader` dialogue box to save the prepared table as a text file.

NOTE: There is no `Undo/Redo` command in the `Text Table Loader` dialogue box. Therefore, it is recommended to save partial results periodically by using the `File > Save` command.

When the table is ready, please press `Import` to load the data into the selected field.

After data has been imported, it is recommended to QC the result; use the mouse to select any loaded well and then choose the command `Database > Data Properties`.



Field: General (m)

Number: 1

x: 490454.81

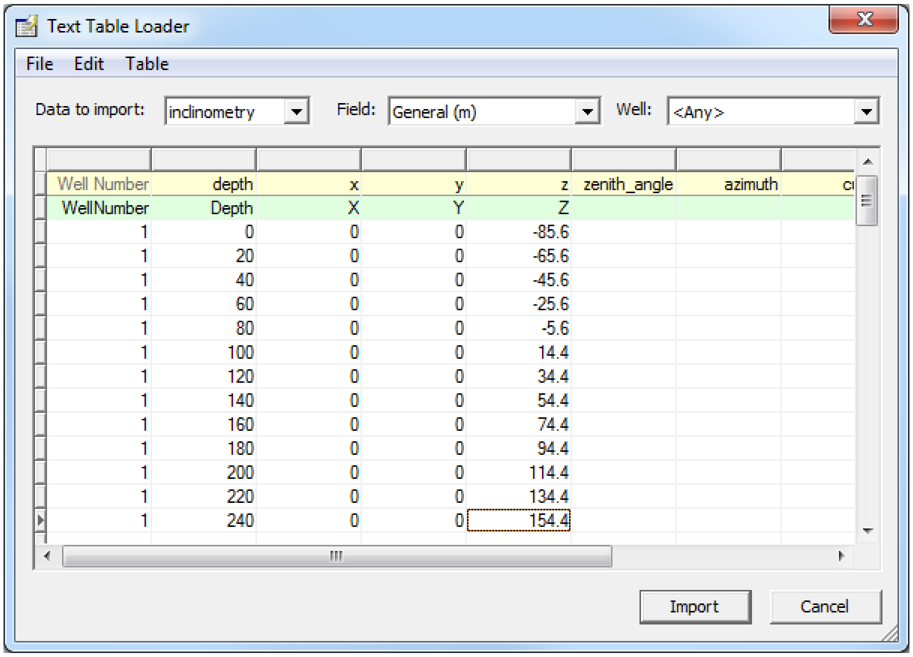
y: 7172923.5

Elevation Kelly Bush (EKB): 85.6

Bottom: 0

In the `Well Properties` dialogue box, you can modify any data and save them to the database using the `OK` button.

STEP 3. Load inclinometry. Generally, loading inclinometry is similar to loading well coordinates. Please select a field where you would like to load the inclinometry data by the command `Database > Prepare Text Table`, and then select `inclinometry` from the `Data to import` list.



Data to import: inclinometry
Field: General (m)
Well: <Any>

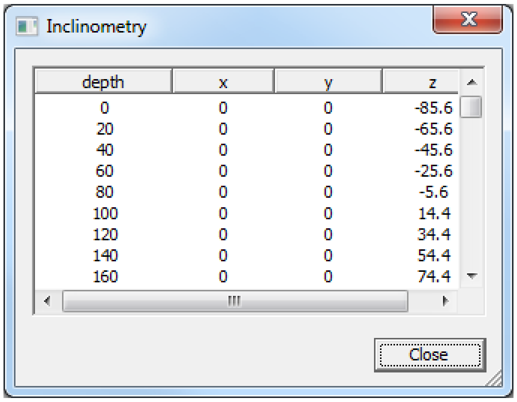
Well Number	depth	x	y	z	zenith_angle	azimuth	c
WellNumber	Depth	X	Y	Z			
1	0	0	0	-85.6			
1	20	0	0	-65.6			
1	40	0	0	-45.6			
1	60	0	0	-25.6			
1	80	0	0	-5.6			
1	100	0	0	14.4			
1	120	0	0	34.4			
1	140	0	0	54.4			
1	160	0	0	74.4			
1	180	0	0	94.4			
1	200	0	0	114.4			
1	220	0	0	134.4			
1	240	0	0	154.4			

To use the inclinometry data in Tesseral Pro, the columns `depth`, `x`, `y`, `z` need to be filled. The remaining columns are only informative and they do not influence the borehole shape.

Apart from the first column (well number), the order of the other columns is not important. The rows order for a single well is also not important, but it is not recommended to have the data in the file related to the same well shaped like “blocks”; it is better to sort all wells by well number.

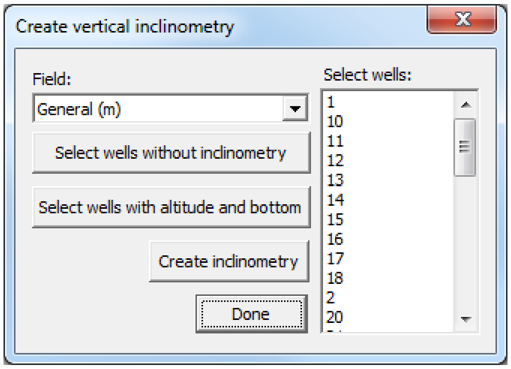
Once the table is ready, please press `Import` to load the data into the selected field.

After loading, it is recommended to check the loading result. For this purpose, please select the `Inclinometry` branch for any of the loaded wells, and then choose the command `Database > Data Properties`.



depth	x	y	z
0	0	0	-85.6
20	0	0	-65.6
40	0	0	-45.6
60	0	0	-25.6
80	0	0	-5.6
100	0	0	14.4
120	0	0	34.4
140	0	0	54.4
160	0	0	74.4

For correct mapping, the table `Inclinometry` must be filled (for the wells you want to use for mapping). If you have no inclinometry data, the wells can be assumed to be vertical, and then the inclinometry data can be generated automatically; this can be done by the command `Database > Create Inclinometry.`

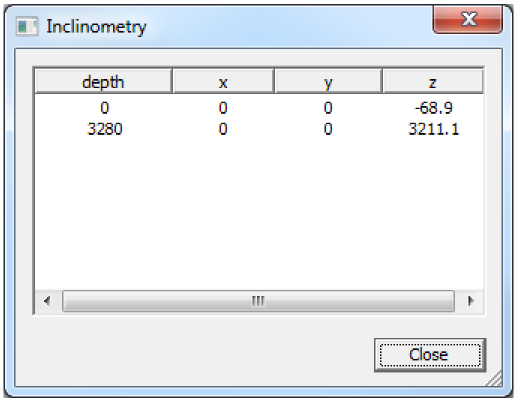

Create vertical inclinometry
Select wells without inclinometry
Select wells with altitude and bottom
Create inclinometry
Done
Select wells:
1
10
11
12
13
14
15
16
17
18
2
20

Field: General (m)

In this dialogue box, please select the wells for inclinometry generation from the list on the right, and then press `Create inclinometry`. For automatic creation of inclinometry, the information about the well's altitude and bottom hole is used from the `wells` table. While creating inclinometry in the absence of this data, you will be prompted to enter the altitude and bottom of the hole manually in a dialogue box.

Use the buttons `Select wells without inclinometry` and `Select wells with altitude and bottom` for automatically selecting the wells in the list.

The result of executing `Create inclinometry` is shown below for a well.

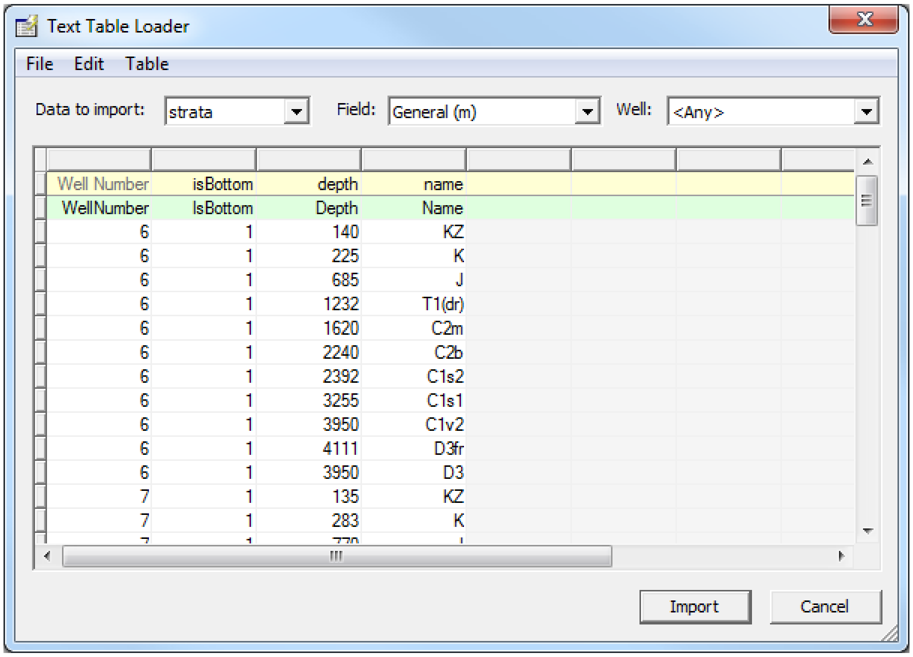

Inclinometry
Close

depth	x	y	z
0	0	0	-68.9
3280	0	0	3211.1

NOTE: In case that the selected well already had inclinometry data, the old data will be deleted.

NOTE: If you do not like the results of loaded inclinometry, please select the field with the mouse and then use the command `Database > Delete from Field > Inclinometry` and repeat loading again.

STEP 4. Load stratigraphy. Generally, loading stratigraphy is similar to loading well coordinates and well inclinometry. Please select the field you want to load the stratigraphic lay-outs with the mouse and then choose the command `Database > Prepare Text Tables`. Please select `strata` from the `Data to import` list.



Data to import: strata
Field: General (m)
Well: <Any>

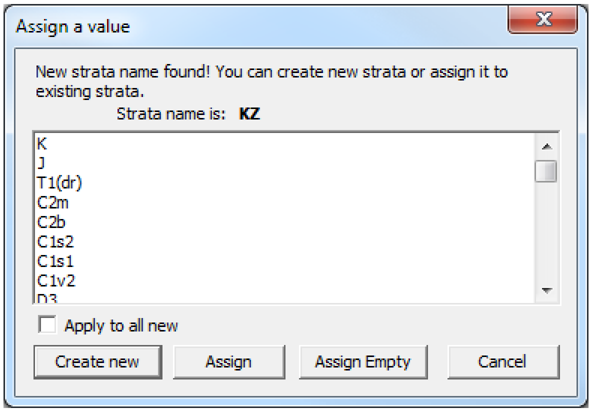
Well Number	isBottom	depth	name
WellNumber	IsBottom	Depth	Name
6	1	140	KZ
6	1	225	K
6	1	685	J
6	1	1232	T1(dr)
6	1	1620	C2m
6	1	2240	C2b
6	1	2392	C1s2
6	1	3255	C1s1
6	1	3950	C1v2
6	1	4111	D3fr
6	1	3950	D3
7	1	135	KZ
7	1	283	K

The main attributes are `name` (layer name), `depth` (layer-intersection depth along the borehole), `isBottom` (1-bottom, 0-top). If the absolute coordinates of the layer-intersection are available, it is worth loading them into the database. Otherwise these coordinates will be calculated automatically every time before calculating a layer surface map.

Apart from the first column (well number), the order of the other columns is not important. It is recommended to sort the rows in advance by well numbers.

Once the table is ready, please click `Import` to load the data into the selected field.

During the loading process, if a layer name is not found in the `strata_code` table, you will be prompted to assign/create a layer code for this layer in the dialogue box below.



New strata name found! You can create new strata or assign it to existing strata.
Strata name is: **KZ**

K
J
T1(dr)
C2m
C2b
C1s2
C1s1
C1v2

☐ Apply to all new

`Create New` is for inserting a new row into the database's layer code table. The new layer code in the well is assigned to this row.

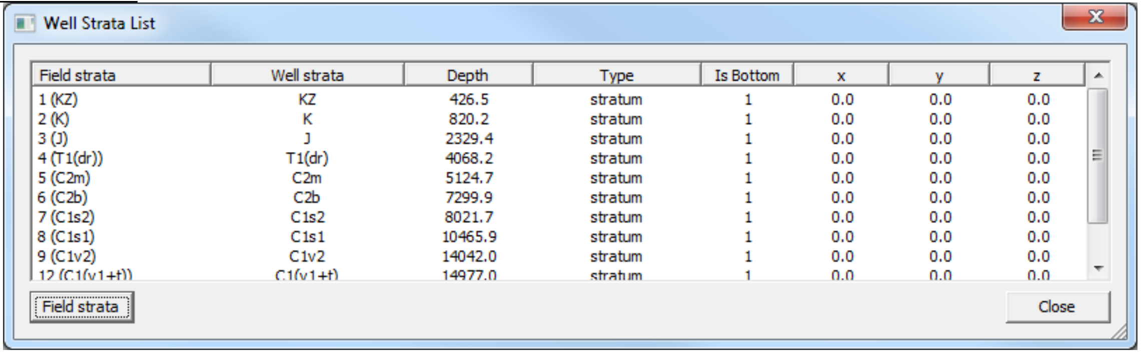
`Assign` is to assign the layer code in the well selected from the list.

`Assign Empty` is for setting the layer code in the well to "0".

`Cancel` for no action

NOTE: The layer code is of great importance for surface-layer building by layer-intersection data and automatic creation of polygons in the model. The attribute `name` is ignored in both cases and only the `strata_code` is used. Thus, it is recommended, whenever possible, to identify the new layer name with an existing code from the `Assign a value` dialogue box.

It is recommended to check the results of the loaded Stratigraphy by selecting the `Strata` branch of any loaded well and then choose the command `Database > Data Properties`.

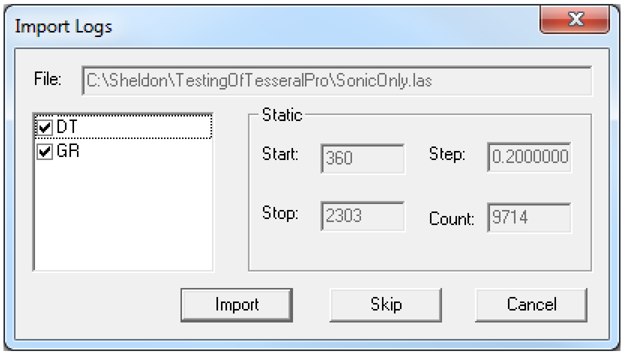


Well Strata List

Field strata	Well strata	Depth	Type	Is Bottom	x	y	z
1 (KZ)	KZ	426.5	stratum	1	0.0	0.0	0.0
2 (K)	K	820.2	stratum	1	0.0	0.0	0.0
3 (J)	J	2329.4	stratum	1	0.0	0.0	0.0
4 (T1(dr))	T1(dr)	4068.2	stratum	1	0.0	0.0	0.0
5 (C2m)	C2m	5124.7	stratum	1	0.0	0.0	0.0
6 (C2b)	C2b	7299.9	stratum	1	0.0	0.0	0.0
7 (C1s2)	C1s2	8021.7	stratum	1	0.0	0.0	0.0
8 (C1s1)	C1s1	10465.9	stratum	1	0.0	0.0	0.0
9 (C1v2)	C1v2	14042.0	stratum	1	0.0	0.0	0.0
12 (C1(v1+t))	C1(v1+t)	14977.0	stratum	1	0.0	0.0	0.0

NOTE: If you do not like the results of the loaded stratigraphy, please select the field with the mouse and then use the command `Database > Delete from Field > Strata` and repeat the loading process again.

STEP 5. Load well log data – The well logging curves are loaded from LAS files for a well or a field with the command `Database > Import data`. A selection of multi LAS files is supported in the dialogue box. After having selected the file(s) and clicking the `Open` button, a dialogue box will appear for loading the curves into the well.



Import Logs

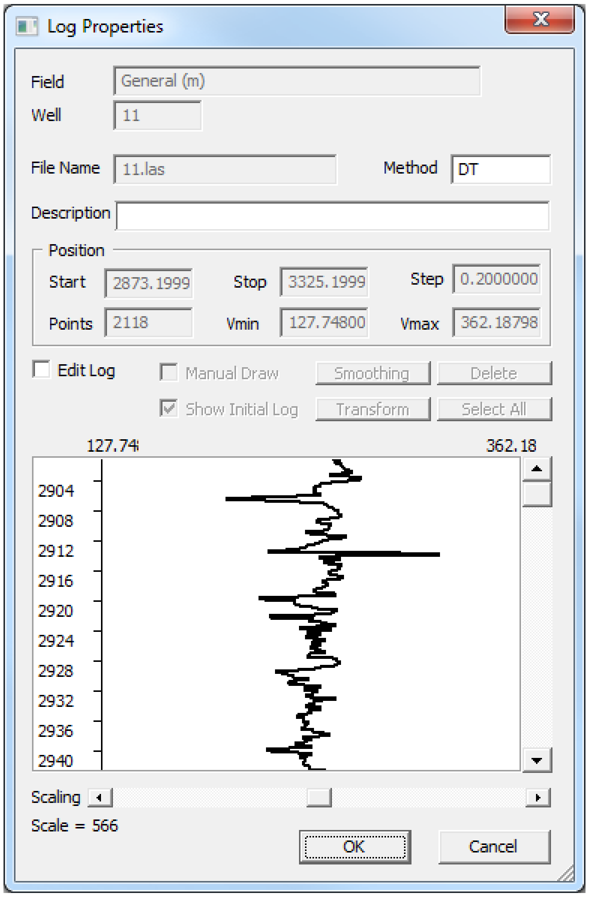
File: C:\Sheldon\TestingOfTesseralPro\SonicOnly.las

☑ DT
☑ GR

Static
Start: 360
Step: 0.2000000
Stop: 2303
Count: 9714

Please click `Import` to load the selected curves into the database.

For QC of the loaded result, please select a curve from the `Logs` branch of the well, and then choose the command `Database > Data Properties`.



Log Properties

Field: General (m)
Well: 11
File Name: 11.las
Method: DT
Description:

Position
Start: 2873.1999
Stop: 3325.1999
Step: 0.2000000
Points: 2118
Vmin: 127.74800
Vmax: 362.18798

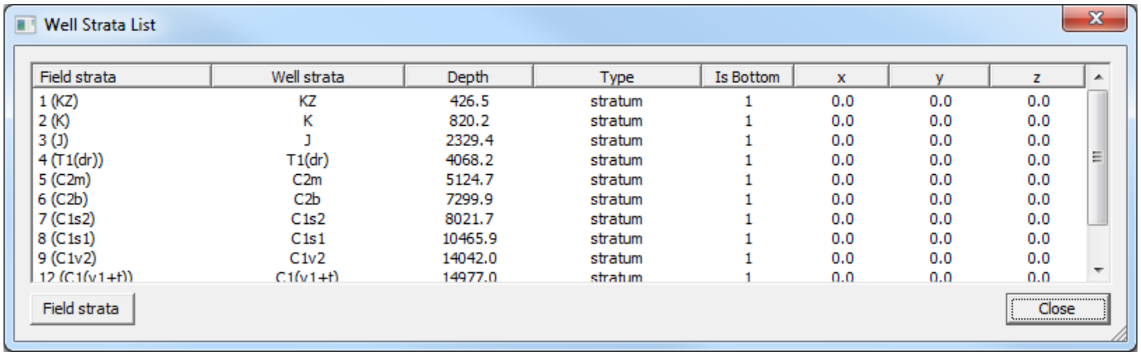
☐ Edit Log
☐ Manual Draw
☑ Show Initial Log

Scale = 566

Smoothing
Delete
Transform
Select All
127.74
362.18
2904
2908
2912
2916
2920
2924
2928
2932
2936
2940
Scaling
OK
Cancel

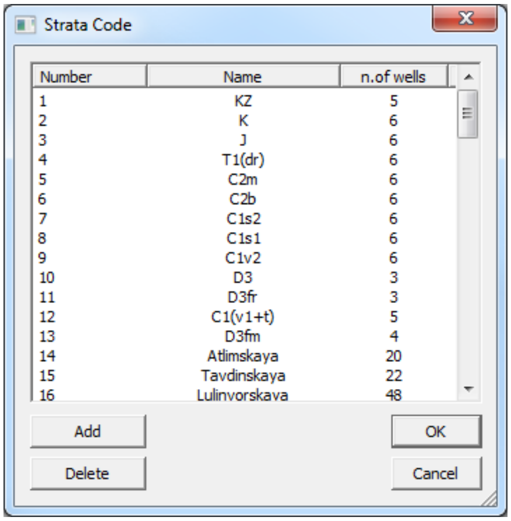
17.6 Data editing

A partial editing of the data loaded from LAS or text files for fields and wells can be done by using the dialogue box (`Database > Data Properties`).



Field strata	Well strata	Depth	Type	Is Bottom	x	y	z
1 (KZ)	KZ	426.5	stratum	1	0.0	0.0	0.0
2 (K)	K	820.2	stratum	1	0.0	0.0	0.0
3 (J)	J	2329.4	stratum	1	0.0	0.0	0.0
4 (T1(dr))	T1(dr)	4068.2	stratum	1	0.0	0.0	0.0
5 (C2m)	C2m	5124.7	stratum	1	0.0	0.0	0.0
6 (C2b)	C2b	7299.9	stratum	1	0.0	0.0	0.0
7 (C1s2)	C1s2	8021.7	stratum	1	0.0	0.0	0.0
8 (C1s1)	C1s1	10465.9	stratum	1	0.0	0.0	0.0
9 (C1v2)	C1v2	14042.0	stratum	1	0.0	0.0	0.0
12 (C1(v1+t))	C1(v1+t)	14977.0	stratum	1	0.0	0.0	0.0

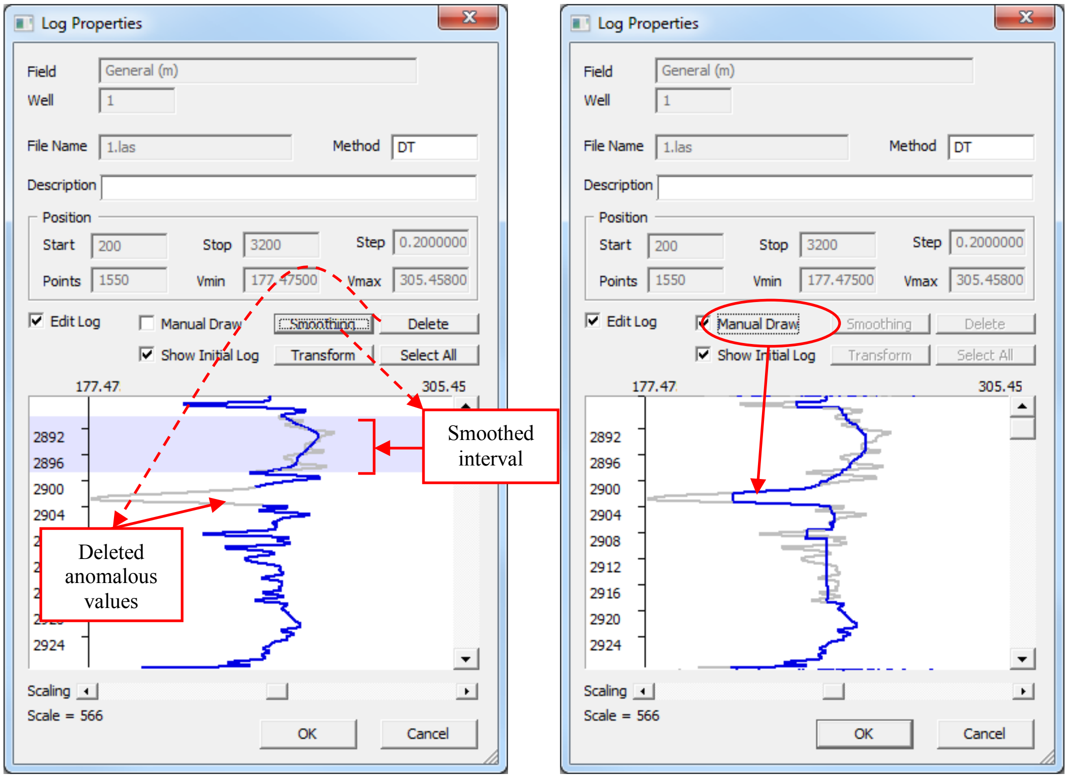
In the `Well Strata List` dialogue box, the layer codes in the database can be inserted, deleted or modified by using the `Field Strata` button.



Number	Name	n.of wells
1	KZ	5
2	K	6
3	J	6
4	T1(dr)	6
5	C2m	6
6	C2b	6
7	C1s2	6
8	C1s1	6
9	C1v2	6
10	D3	3
11	D3fr	3
12	C1(v1+t)	5
13	D3fm	4
14	Atlimskaya	20
15	Tavdinskaya	22
16	Lulinvorskaya	48

NOTE: To change the layer code name, please double click on-its current name and then change the name in the edit field.

To edit the log curve, choose the command `Database > Data Properties` and select the curve name from the database tree.


Log Properties

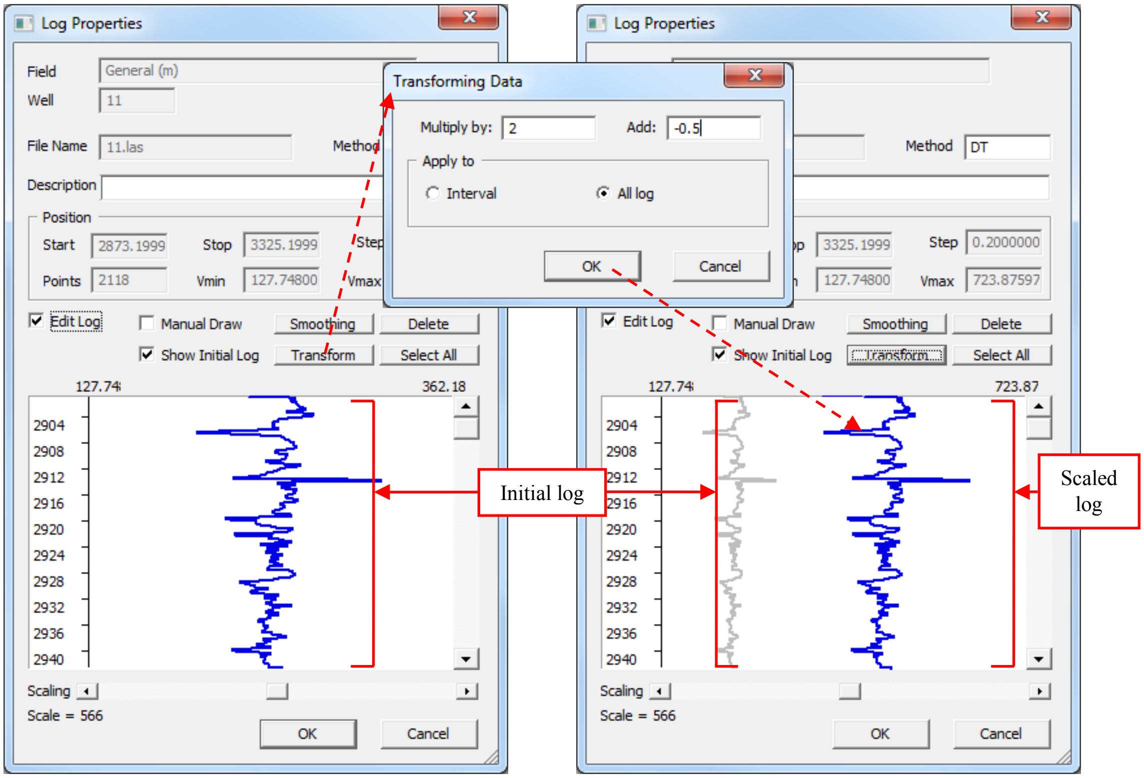
Field: General (m)
Well: 1
File Name: 1.las
Method: DT
Description:
Position
Start: 200
Stop: 3200
Step: 0.2000000
Points: 1550
Vmin: 177.47500
Vmax: 305.45800
☑ Edit Log
☐ Manual Draw
☑ Show Initial Log
Scale = 566

Log Properties

Field: General (m)
Well: 1
File Name: 1.las
Method: DT
Description:
Position
Start: 200
Stop: 3200
Step: 0.2000000
Points: 1550
Vmin: 177.47500
Vmax: 305.45800
☑ Edit Log
☑ Manual Draw
☑ Show Initial Log
Scale = 566

Smoothing
Delete
Transform
Select All
177.47
305.45
2892
2896
2900
2904
2924
Scaling
OK
Cancel
Smoothed interval
Deleted anomalous values

In the `Log Properties` dialogue box, please check `Edit Log` checkbox to enter the log editing mode. Then select the log interval by the mouse (press-drag-release), or use the button `Select All` to select the entire log. The selected log interval can be smoothed by using the `Smoothing` button or scaled by using the `Transform` button, or deleted by using the `Delete` button. A log interval can be drawn manually by using the mouse (press-drag-release) while the `Manual Draw` checkbox is checked.


Log Properties

Field: General (m)
Well: 11
File Name: 11.las
Description:
Position
Start: 2873.1999
Stop: 3325.1999
Points: 2118
Vmin: 127.74800
☑ Edit Log
☐ Manual Draw
☑ Show Initial Log
Scale = 566

Transforming Data

Multiply by: 2
Add: -0.5
Apply to
○ Interval
● All log

Log Properties

Method: DT
Stop: 3325.1999
Step: 0.2000000
Vmin: 127.74800
Vmax: 723.87597
☑ Edit Log
☐ Manual Draw
☑ Show Initial Log
Scale = 566

Smoothing
Delete
Transform
Select All
127.74
362.18
723.87
2904
2908
2912
2916
2920
2924
2928
2932
2936
2940
Scaling
OK
Cancel
Initial log
Scaled log

18 Annex 3: Licensing policy

Tesseral Technologies Inc provides several ways to license Tesseral Pro. For detailed information about license policy, please contact tesseral@shaw.ca

18.1 Single-user License

A ***local alpha-digital key*** is bundled to a particular computer. Licensing with the alpha-digital key does not allow using this key in any other computers. This may be the most suitable choice for the package's trial license, a public standalone PC or permanent user-independent workplaces like a computer class at a training facility.

A ***local hardware key (HASP)*** provides the licensing when the HASP is plugged into a USB port of a computer. User can install the same Tesseral product on other workstations and use the same key. So this type of licensing is the most suitable for occasionally using Tesseral package on multiple work-places, e.g. both at home and in the office.

18.2 Network License

A network license is unique for the client's network. The license key is usually installed on one of the network PCs called a Server. It may be the best choice for bigger or scattered companies. Due to the increasingly toughening policies in Windows system administration, it may require some additional network administrating efforts (eliminating possible interference with particular network security features and local network Firewall settings) to support such configuration, but this type of licensing allows multiple users to utilize the common license directly from multiple network PCs, but a program must be initially installed on each of computers where Tesseral is running.

- A network alpha-digital key license is unique for the client's network. The license key is installed on one of the PCs from the network (a Server PC); it may be a virtual machine because this type of licensing does not require special hardware.
- A network hardware (HASP) key provides licensing when HASP is plugged into a USB port of any computer in the local network or VPN (Virtual Personal Network) to which the user's computer is connected.

18.3 Mixed Licenses

Any combination of the types of keys mentioned above can be used by the client for licensing Tesseral products. For example, a network HASP key for 3 workplaces, 2 local USB HASP keys and 2 alpha-digital keys can be purchased and used together as a license for 3+2+2=6 workplaces. Each type of key may be accompanied with a particular variant of the Tesseral product.

Licensing for evaluation period is usually done with local alpha-digital key.

18.4 Setting up a license

Licensing with Hardware key (HASP) allows users to run the Tesseral package by plugging an electronic USB device (called the HASP key – "**H**ardware **A**gainst **S**oftware **P**iracy") supplied by Tesseral Technologies Inc into a computer's USB port. The HASP key (Guardant) driver is Microsoft-certified.

A HASP key is initially coded for the latest version of a particular Tesseral product and configuration and might not work with future versions released as the package is developed. Upon the user request and payment for upgrade, this key can be coded for the upgraded version and product configuration via e-mail (users will receive necessary instructions in this case).

HASP key can be coded for un-limited period (permanent) or limited period (trial or leasing period), and, after this period, the package will not work until user gets a new permanent HASP key from Tesseral Technologies Inc or a code from Tesseral Technologies Inc via e-mail.

A HASP key is not bundled with a particular Tesseral installation CD.

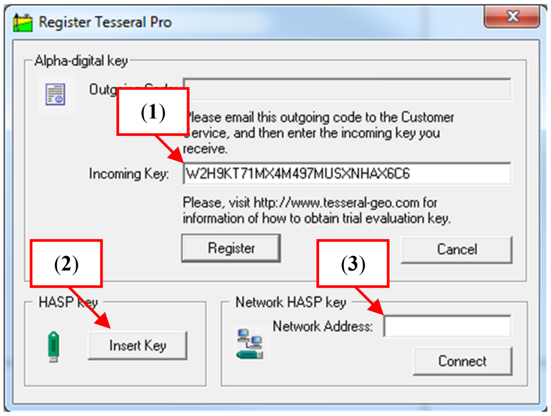
The user must keep the HASP key and not lose it, because the company does not provide replacement of the HASP key, because it is impossible to verify the number of licenses actually used in this case. If a HASP key is damaged, users must inform company's Customer Service by e-mail and then send it via mail to the provided address to get a replacement key for its market price (about US$ 50 for shipping and handling).

The green indicator on the USB device means that the drivers are correctly installed.

IMPORTANT NOTE!

The new (2008) HASP drivers are strictly linked to the Windows' (not computer's!) bit number (32 or 64 bit). During the installation, the program recognizes the Windows type and installs the corresponding drivers. Insert the USB key only after the installation has finished. You can't mix 32-bit with 64-bit drivers if you have to install them manually.

The first time you run Tesseral Pro, the Registration Dialogue (see figure below) request users to specify corresponding license information.



lease email this outgoing code to the Customer ervice, and then enter the incoming key you receive.

Incoming Key: W2H9KT71MX4M497MUSXNHAX6C6

Please, visit http://www.tesseral-geo.com for information of how to obtain trial evaluation key.

Depending on the license type, you have several options:

(**1**) Enter the alpha-digital key and press "Register"

(**2**) Insert the USB key and press "Insert Key"

(**3**) Enter the address of a Network Key Server and press "Connect"

18.5 Installing Guardant Network Services

To use network USB keys, it is required to install the Guardant Network Services on your computer that will serve as the key server. If you are not using network license, you may skip this section.

The Guardant Network Services can be downloaded for free by following this link:

http://www.geopoisk.com/tesseral/download/GuardnetNetServices.zip

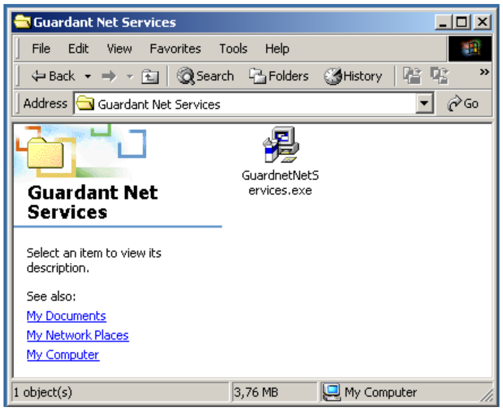
Detailed guide for installing Guardant Network Services can be downloaded by following this next link:

http://www.tesseral-geo.com/documentation/en/license/
TesseralNetworkLicenseInstallation.pdf

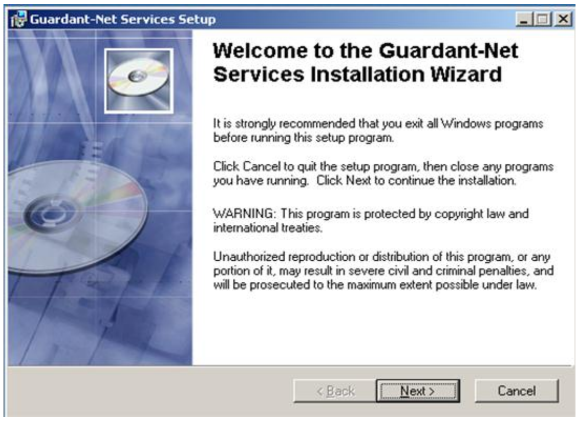
More technical details are described in the key vendor's manual:

http:/www.tesseral-geo.com/documentation/en/license/Guardant_LAN_Guide.pdf

Unzip and run the installation program:


Guardant Net Services
File Edit View Favorites Tools Help
Back Search Folders History
Address Guardant Net Services
Go
Guardant Net Services
Select an item to view its description.
See also:
My Documents
My Network Places
My Computer
GuardnetNetServices.exe
1 object(s)
3,76 MB
My Computer

STEP 1. Click Next >


Guardant-Net Services Setup
< Back
Next >
Cancel

Welcome to the Guardant-Net Services Installation Wizard

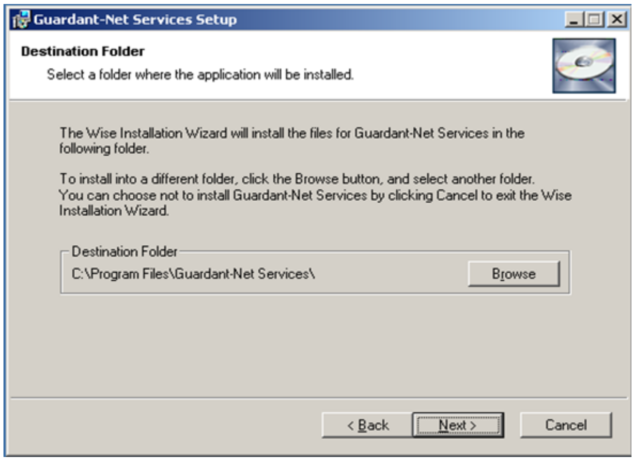
It is strongly recommended that you exit all Windows programs before running this setup program.

Click Cancel to quit the setup program, then close any programs you have running. Click Next to continue the installation.

WARNING: This program is protected by copyright law and international treaties.

Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.

STEP 2. Select the Destination Folder and press Next >


Guardant-Net Services Setup
Destination Folder
Select a folder where the application will be installed.

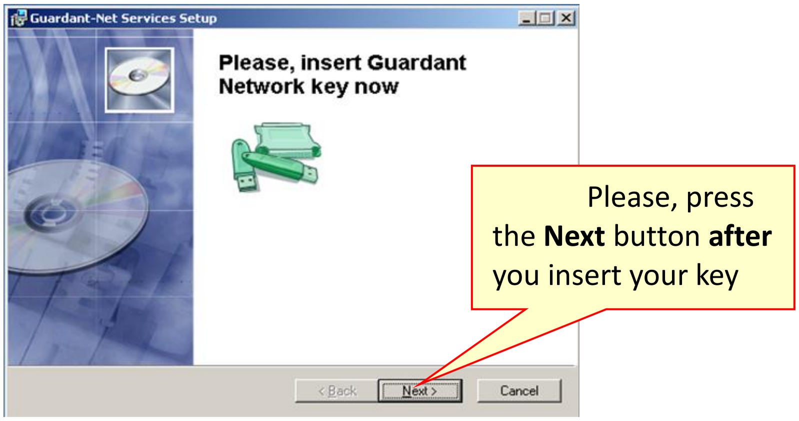
The Wise Installation Wizard will install the files for Guardant-Net Services in the following folder.

To install into a different folder, click the Browse button, and select another folder. You can choose not to install Guardant-Net Services by clicking Cancel to exit the Wise Installation Wizard.

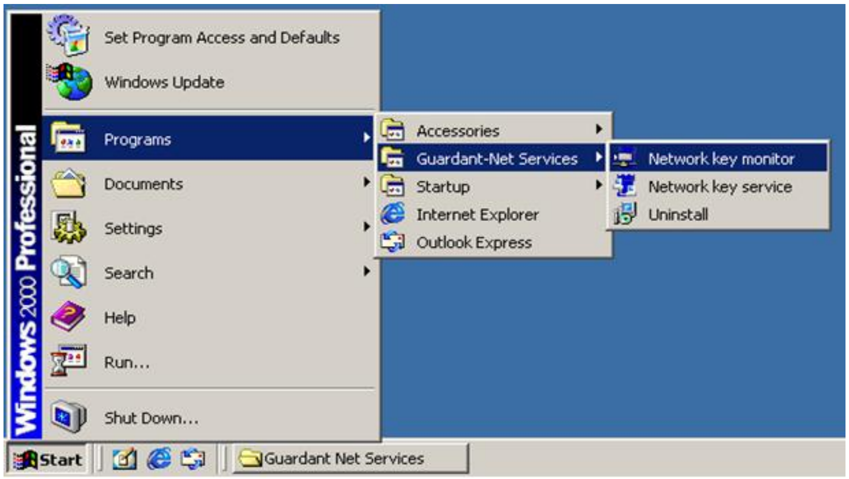
Destination Folder
C:\Program Files\Guardant-Net Services\

Browse
< Back
Next >
Cancel

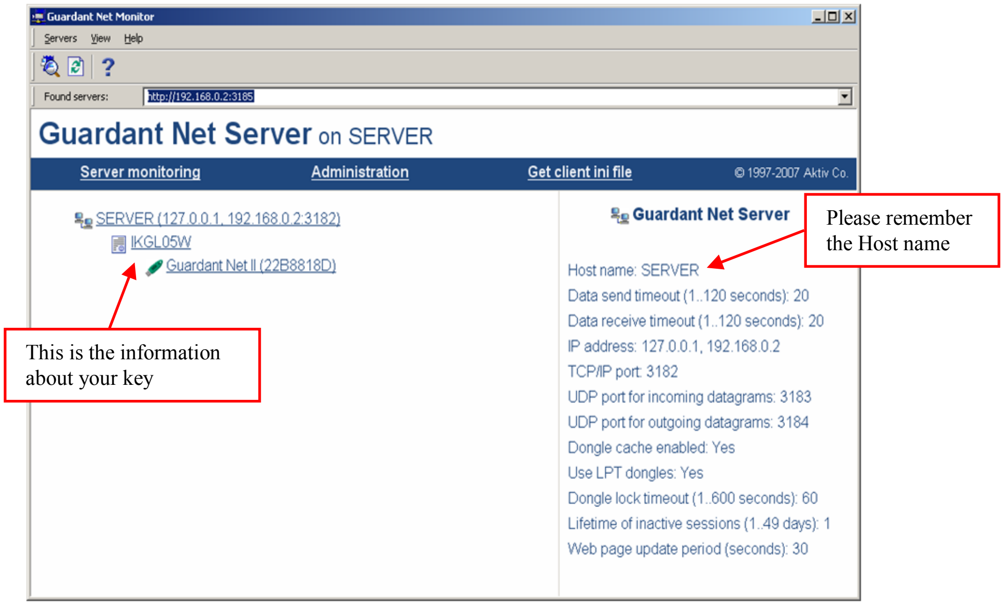
STEP 3. Insert your USB key and then press Next >


Guardant-Net Services Setup
Please, insert Guardant Network key now
Please, press the **Next** button **after** you insert your key
< Back
Next >
Cancel

a) You may run "Network key monitor" to check if your key is working properly


Windows 2000 Professional
Set Program Access and Defaults
Windows Update
Programs
Documents
Settings
Search
Help
Run...
Shut Down...
Accessories
Guardant-Net Services
Startup
Internet Explorer
Outlook Express
Network key monitor
Network key service
Uninstall
Start
Guardant Net Services

b) ... and check: The "Host name"


Guardant Net Monitor
Servers View Help
Found servers:
http://192.168.0.2:3185
Server monitoring
Administration
Get client ini file
© 1997-2007 Aktiv Co.
SERVER (127.0.0.1, 192.168.0.2:3182)
IKGL05W
Guardant Net II (22B8818D)

Guardant Net Server on SERVER

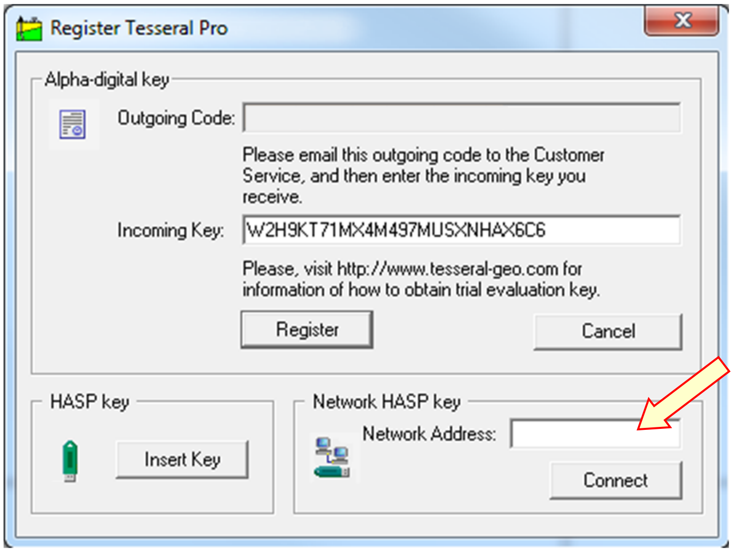
Guardant Net Server

Host name: SERVER
Data send timeout (1..120 seconds): 20
Data receive timeout (1..120 seconds): 20
IP address: 127.0.0.1, 192.168.0.2
TCP/IP port: 3182
UDP port for incoming datagrams: 3183
UDP port for outgoing datagrams: 3184
Dongle cache enabled: Yes
Use LPT dongles: Yes
Dongle lock timeout (1..600 seconds): 60
Lifetime of inactive sessions (1..49 days): 1
Web page update period (seconds): 30

Please remember the Host name

This is the information about your key

STEP 4. To use the Remote USB key, please enter the "Host name" in the Tesseral registration dialogue box and press "Connect"


Register Tesseral Pro
Alpha-digital key
Outgoing Code:
Register
Cancel
HASP key
Insert Key
Network HASP key
Network Address:
Connect

Please email this outgoing code to the Customer Service, and then enter the incoming key you receive.

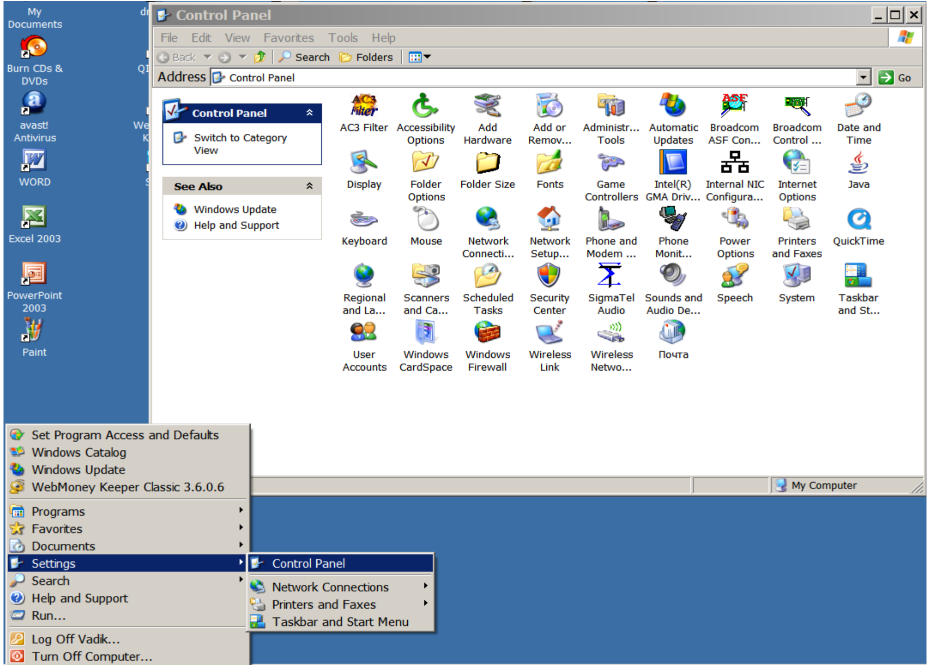
Incoming Key: W2H9KT71MX4M497MUSXNHAX6C6

Please, visit http://www.tesseral-geo.com for information of how to obtain trial evaluation key.

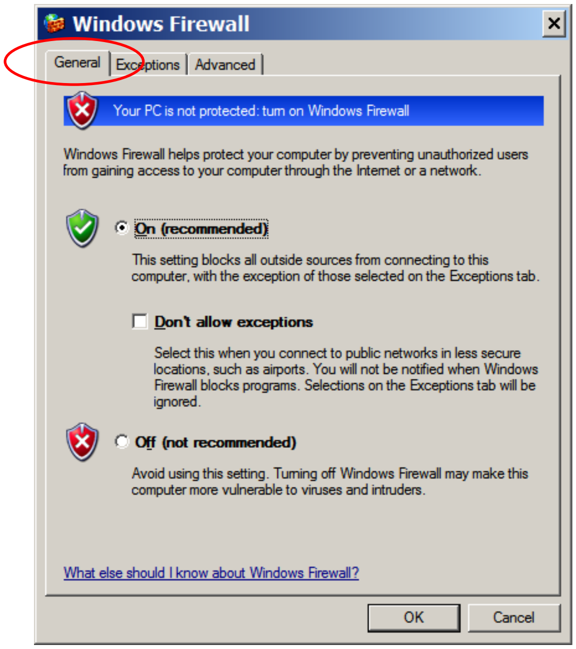
18.5.1 Troubleshooting

Read this part only when you encounter problems

1. **Technical information for system administrators**
    - Guardant Network Services use the following TCP/IP ports (both ingoing and outgoing):
        - 3182/TCP
        - 3183/UDP
        - 3184/UDP
    - Configuration files for advanced settings:
        - For server: NNKSRV32.INI (in Guardant Net Services directory)
        - For client: GNCLIENT.INI (In Tesseral Directory)
2. **Setting up the Firewall for system administrators**
    - **a.** Open **Start > Settings > Control Panel** then **Windows Firewall**


Control Panel
File Edit View Favorites Tools Help
Back Search Folders
Address Control Panel
Go
Control Panel
Switch to Category View
See Also
Windows Update
Help and Support
AC3 Filter
Accessibility Options
Add Hardware
Add or Remov...
Administr... Tools
Automatic Updates
Broadcom ASF Con...
Broadcom Control ...
Date and Time
Display
Folder Options
Folder Size
Fonts
Game Controllers
Intel(R) GMA Driv...
Internal NIC Configura...
Internet Options
Java
Keyboard
Mouse
Network Connecti...
Network Setup...
Phone and Modem ...
Phone Monit...
Power Options
Printers and Faxes
QuickTime
Regional and La...
Scanners and Ca...
Scheduled Tasks
Security Center
SigmaTel Audio
Sounds and Audio De...
Speech
System
Taskbar and St...
User Accounts
Windows CardSpace
Windows Firewall
Wireless Link
Wireless Netwo...
Почта
My Computer
My Documents
Burn CDs & DVDs
avast! Antivirus
WORD
Excel 2003
PowerPoint 2003
Paint
Set Program Access and Defaults
Windows Catalog
Windows Update
WebMoney Keeper Classic 3.6.0.6
Programs
Favorites
Documents
Settings
Search
Help and Support
Run...
Log Off Vadik...
Turn Off Computer...
Control Panel
Network Connections
Printers and Faxes
Taskbar and Start Menu

    - **b.** Setting up the Firewall: Click “**Advanced**” tab then “**Settings**” button



Windows Firewall

General
Exceptions
Advanced

Your PC is not protected: turn on Windows Firewall

Windows Firewall helps protect your computer by preventing unauthorized users from gaining access to your computer through the Internet or a network.

● **On (recommended)**

This setting blocks all outside sources from connecting to this computer, with the exception of those selected on the Exceptions tab.

☐ **Don't allow exceptions**

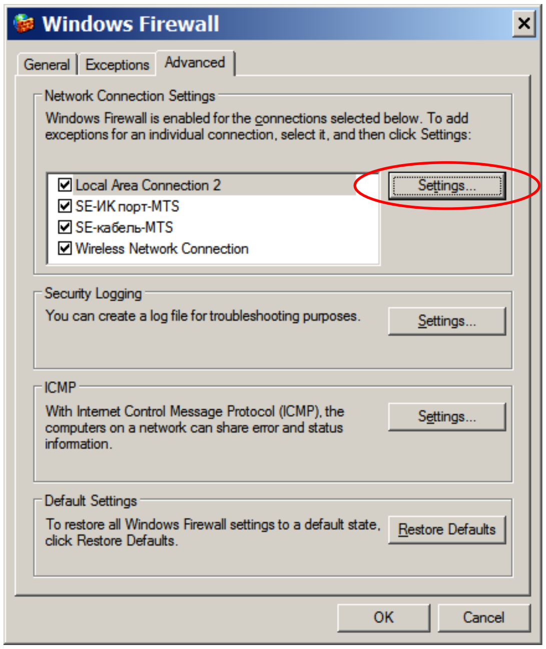
Select this when you connect to public networks in less secure locations, such as airports. You will not be notified when Windows Firewall blocks programs. Selections on the Exceptions tab will be ignored.

○ **Off (not recommended)**

Avoid using this setting. Turning off Windows Firewall may make this computer more vulnerable to viruses and intruders.

What else should I know about Windows Firewall?

OK
Cancel



Windows Firewall

General
Exceptions
Advanced

Network Connection Settings

Windows Firewall is enabled for the connections selected below. To add exceptions for an individual connection, select it, and then click Settings:

☑ Local Area Connection 2
☑ SE-ИК порт-MTS
☑ SE-кабель-MTS
☑ Wireless Network Connection

Settings...

Security Logging

You can create a log file for troubleshooting purposes.

Settings...

ICMP

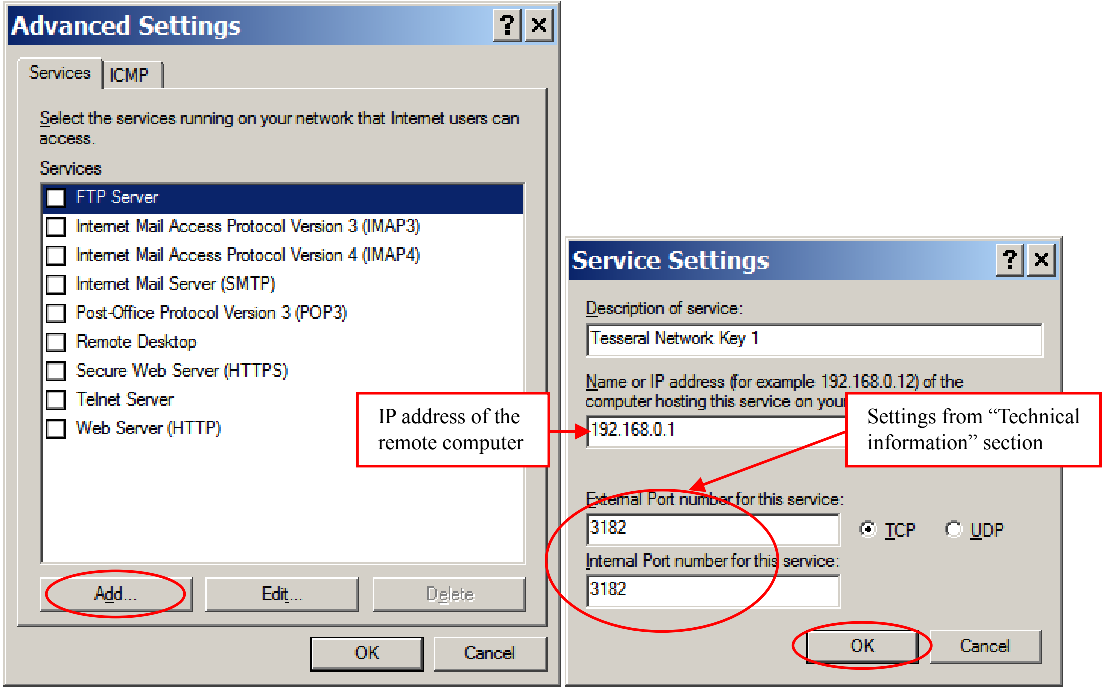
With Internet Control Message Protocol (ICMP), the computers on a network can share error and status information.

Default Settings

To restore all Windows Firewall settings to a default state, click Restore Defaults.

Restore Defaults
OK
Cancel

c. Click "**Add**", then enter connection data for "**3182**" port, then click "OK"



Advanced Settings

Services
ICMP

Select the services running on your network that Internet users can access.

Services

☐ FTP Server
☐ Internet Mail Access Protocol Version 3 (IMAP3)
☐ Internet Mail Access Protocol Version 4 (IMAP4)
☐ Internet Mail Server (SMTP)
☐ Post-Office Protocol Version 3 (POP3)
☐ Remote Desktop
☐ Secure Web Server (HTTPS)
☐ Telnet Server
☐ Web Server (HTTP)

Add...
Edit...
Delete
OK
Cancel

Service Settings

Description of service: Tesseral Network Key 1

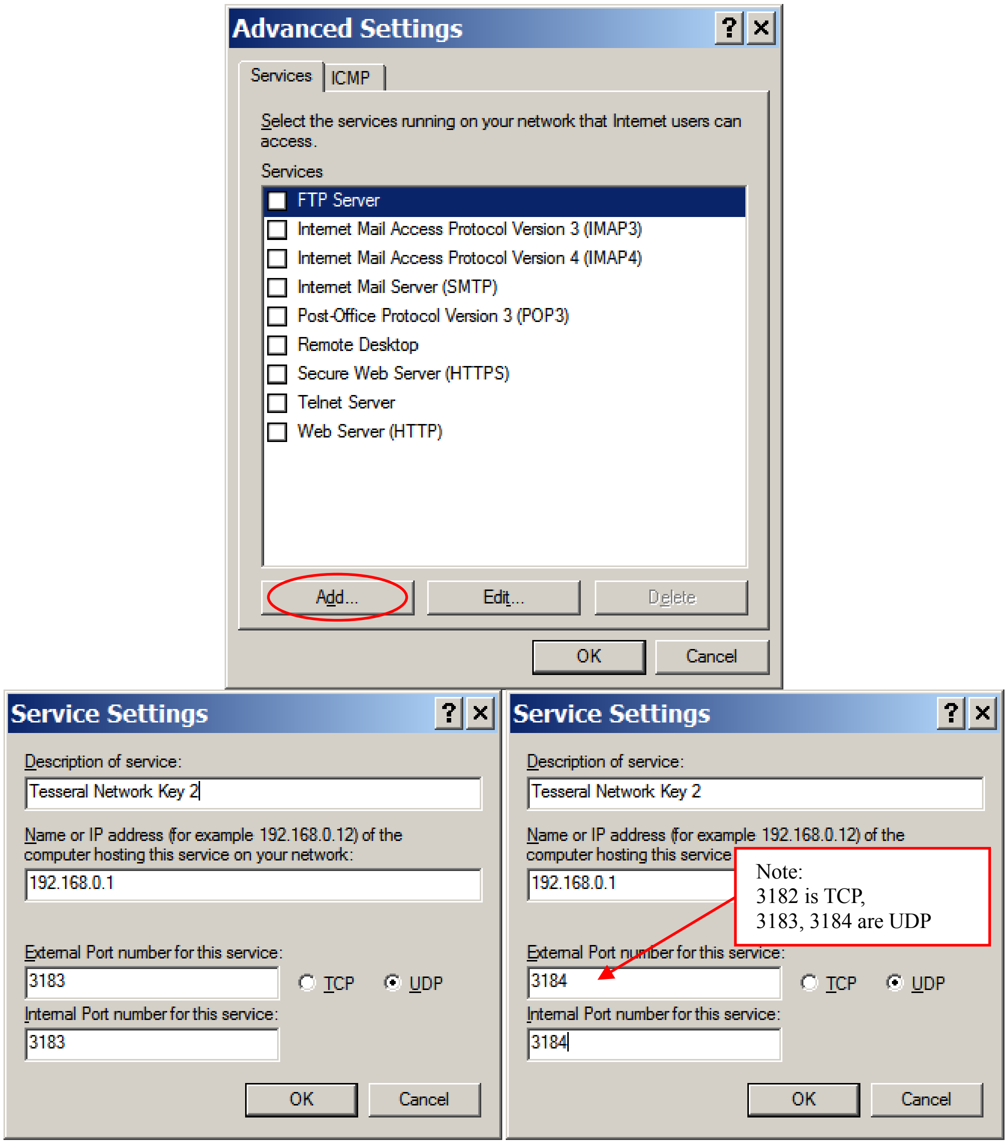
Name or IP address (for example 192.168.0.12) of the computer hosting this service on your network: 192.168.0.1

External Port number for this service: 3182 ● TCP ○ UDP

Internal Port number for this service: 3182

OK
Cancel
IP address of the remote computer
Settings from "Technical information" section

d. Repeat for the "**3183**" and "**3184**" ports


Advanced Settings
Services
ICMP
Add...
Edit...
Delete
OK
Cancel
Service Settings
OK
Cancel
Service Settings
OK
Cancel

Select the services running on your network that Internet users can access.

Services

- ☐ FTP Server
- ☐ Internet Mail Access Protocol Version 3 (IMAP3)
- ☐ Internet Mail Access Protocol Version 4 (IMAP4)
- ☐ Internet Mail Server (SMTP)
- ☐ Post-Office Protocol Version 3 (POP3)
- ☐ Remote Desktop
- ☐ Secure Web Server (HTTPS)
- ☐ Telnet Server
- ☐ Web Server (HTTP)

Description of service: Tesseral Network Key 2

Name or IP address (for example 192.168.0.12) of the computer hosting this service on your network: 192.168.0.1

External Port number for this service: 3183 ○ TCP ● UDP

Internal Port number for this service: 3183

Description of service: Tesseral Network Key 2

Name or IP address (for example 192.168.0.12) of the computer hosting this service on your network: 192.168.0.1

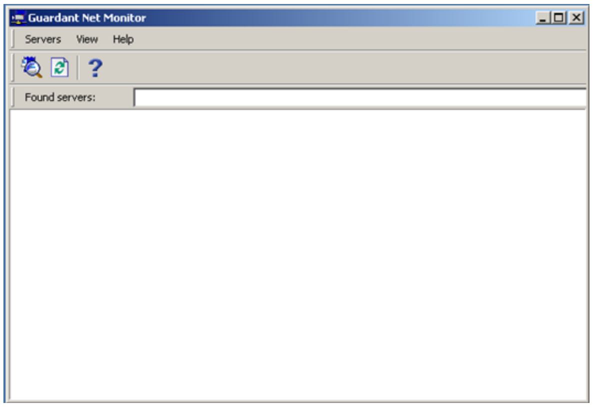
External Port number for this service: 3184 ○ TCP ● UDP

Internal Port number for this service: 3184

Note:
3182 is TCP,
3183, 3184 are UDP

3. Questions and Answers:

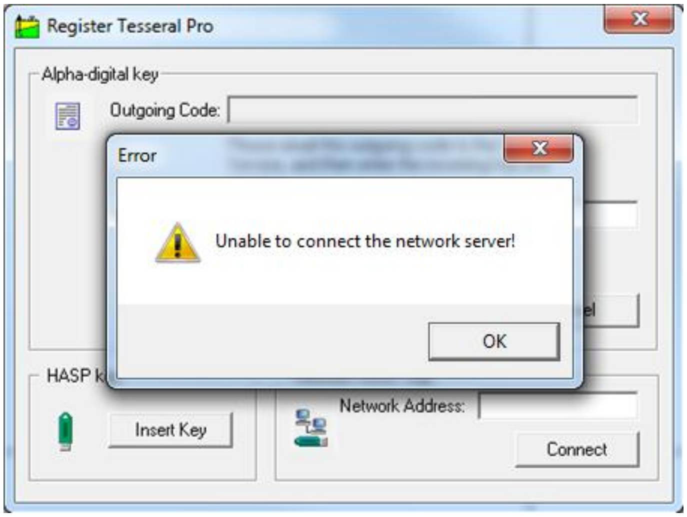
a. Q: Network key monitor shows “blank” window


Guardant Net Monitor
Servers
View
Help
Found servers:

Please, try following:

- Check if the green indicator in the USB key is lit. If not, please, download and install the latest drivers.
- Try to reboot your server
- Check your firewall (please see 2 in Section *18.5.1*)

b. Q: Tesseral 2D/Pro does not “see” the network key


Register Tesseral Pro
Alpha-digital key
Outgoing Code:
Error
OK
HASP k
Insert Key
Network Address:
Connect

Unable to connect the network server!

Please, try the following:

- Check your firewall (please see 2 in Section *18.5.1*)
- Check the configuration in ***gnclient.ini*** file in Tesseral program directory